Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXIII. DECEMBER, 1922 No. 6

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Price: Single copy 25 cents. Annual subscription in U. S. $2.00; Canada, $2.40; Foreign, $2.75.

MUNICIPAL AND COUNTY ENGINEERING is published monthly by Engineering Publishing Company, 702 Wulsin Building, INDIANAPOLIS, INDIANA, A. P. FOX, President, J. H. Pritchard, Secretary.

Changes of address, subscriptions and remittances should be addressed to MUNICIPAL AND COUNTY ENGINEERING, Indianapolis, Indiana. Editorial and business communications should also be addressed to 702 Wulsin Bldg., Indianapolis, Ind.

Editorial and Advertising Offices also at 702 Wulsin Bldg., Indianapolis, Ind. Samuel C. Hadden, Editor and General Manager.

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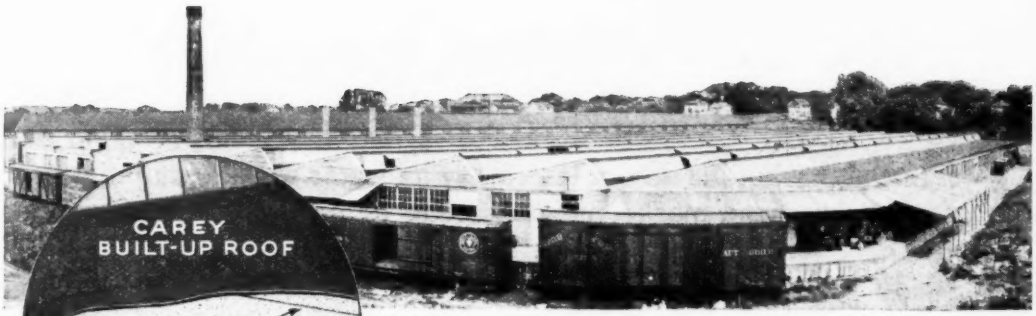

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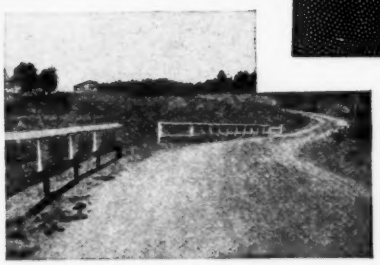

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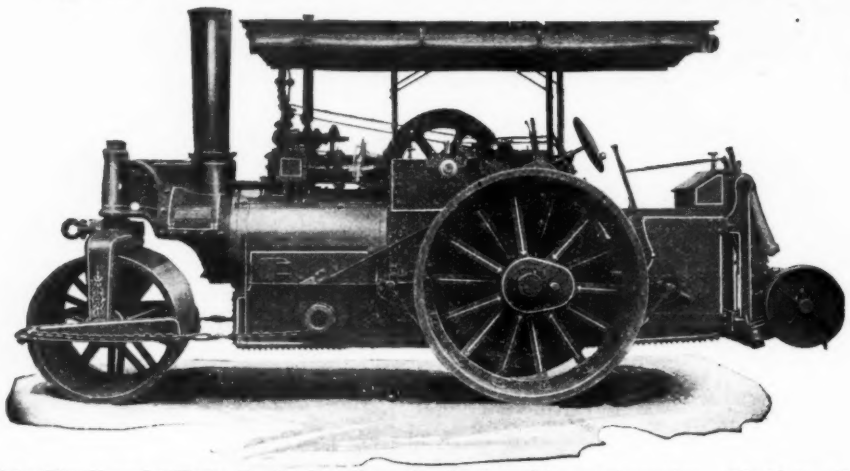

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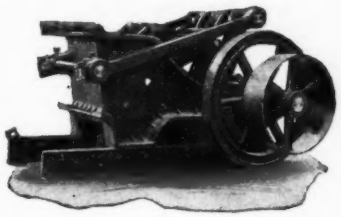

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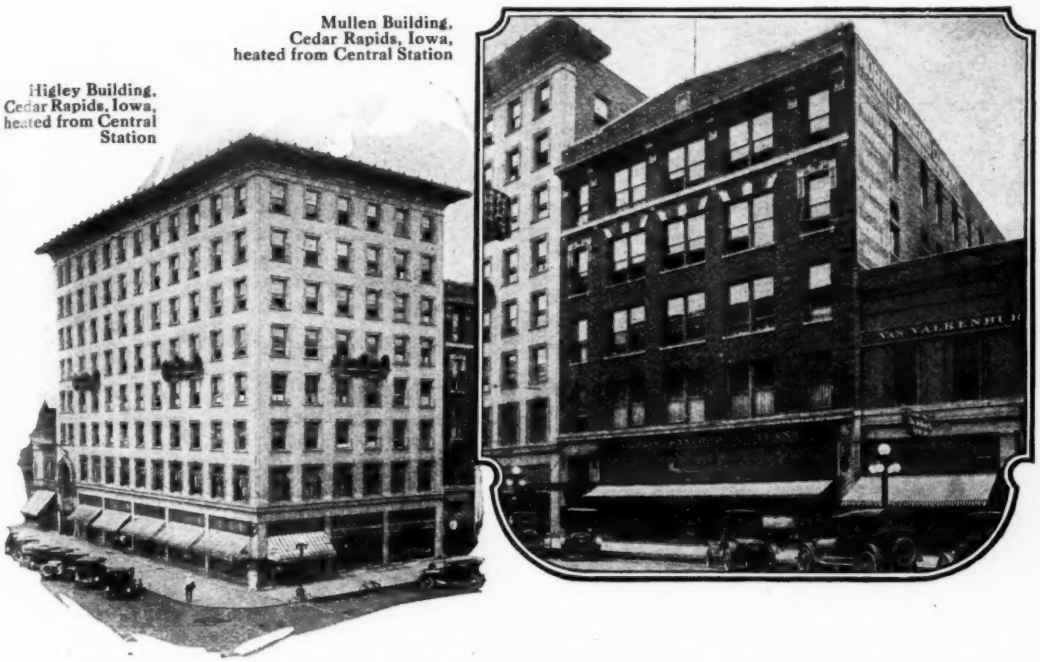

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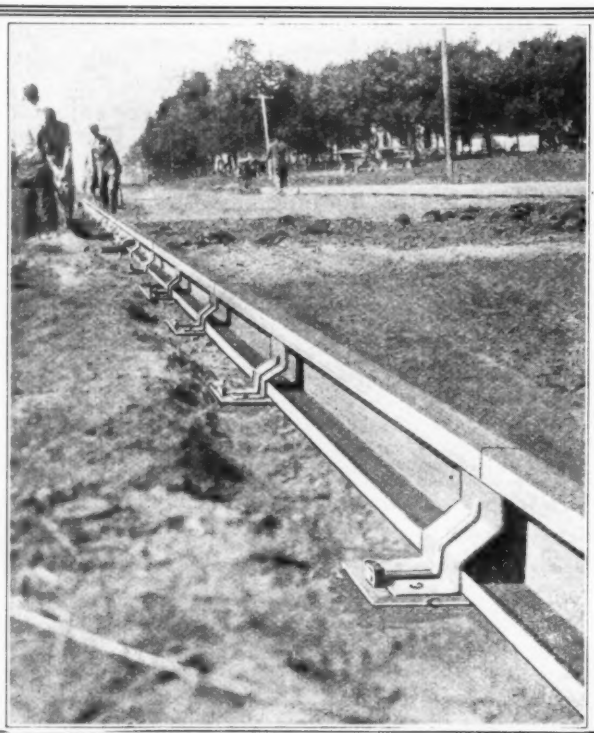

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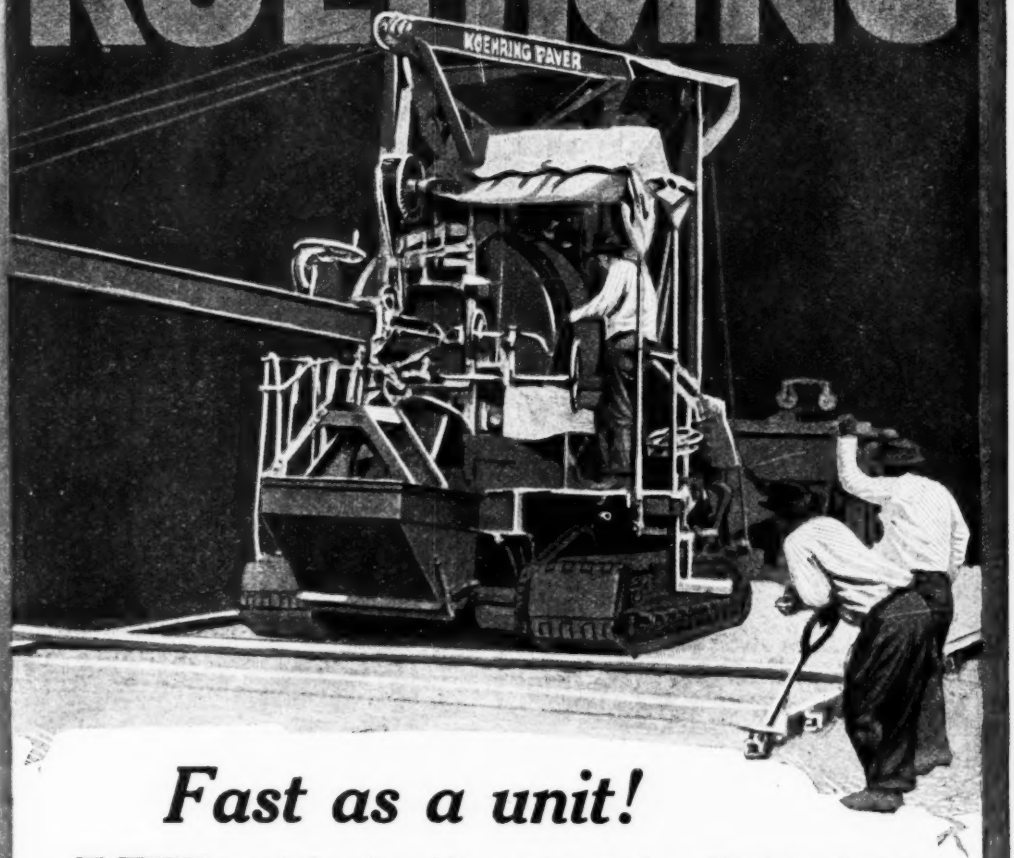

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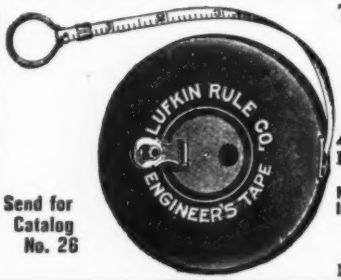

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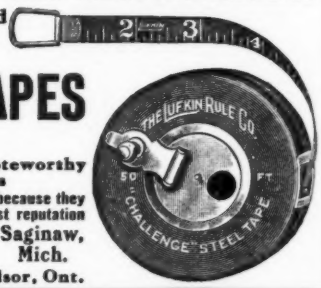

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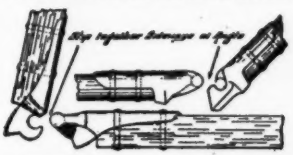

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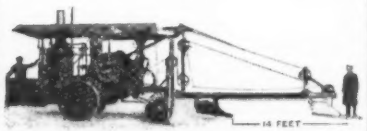

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EDITORIAL

THE CRAZE TO REGULATE MOTOR TRAFFIC

Public officials in every state and in every city are taxing their minds to evolve new methods of regulating motor traffic. There is a great volume of public sentiment favoring drastic forms of regulation, much of it fostered by interests opposed to highway development and to motor transportation. In some cities traffic regulations are changed so often that it is only by following the newspapers carefully from day to day that the resident motorist can operate his car without laying himself liable to arrest, fines and even imprisonment, while the tourist is totally unable to conduct himself in a manner to avoid harsh criticism. Cities are requiring city license tags in many cases and are not granting reciprocal courtesies to visiting motorists. A truck operator finds himself a stranger in a strange land when he crosses a state line and, often, when he visits a neighboring city in his own state. The freedom of movement by motor that has done so much in recent years to make this a real nation with a national conscience and viewpoint is endangered. We are trending backward toward provincialism. Soon we may be no better off than Europe where tourists sometimes are stopped at the border, searched, stripped and disinfected. Many unhappy possibilities exist in the present disposition to outlaw the motorized citizen.

There is at present an infinite variety of regulations governing every conceivable phase of motoring, ranging from proof of ownership on demand to where and how long one may park and on what thoroughfares and at what speed one may drive. Many mechanical features of the machine are subjected to regulation and every form of regulation of the use of the vehicle that ingenuity can conjure up has been tried at least once. Then there is the subject of taxation on the vehicle and its use, especially its uses as a common carrier and in general commercial operation. A multitude of regulations, many of them unfair, some of them purposely unfair, now vex the owner, drive the dealer mad and the manufacturer into bankruptcy.

The great motor industry cannot long survive these virulent spasms of regulation but it can adjust itself to sane, well-considered regulation. In fact, proper regulation will be welcomed by every owner of a vehicle but he wants sane and uniform regulation so that he can operate safely if he gets off his daily beat between his home and his office. The man who purchases a truck for any use and especially those who operate truck and bus lines have a right to know what regulations of all sorts will be imposed on them for a reasonable period in the future.

The very nature of motor traffic, its great range, makes attempts at purely local regulations ridiculous. Uniform regulation throughout the country is urgently needed in the interest of all. We understand an attempt will be made at the coming annual meeting of the American Road Builders' Association to formulate a recommended set of uniform highway traffic regulations for nation-wide use. These questions of traffic regulation, vehicle taxation, excise taxes, taxes and franchises on truck and bus lines, etc., are now of paramount importance. The use of the highway now looms larger than its construction and we hope all who attend the convention will go prepared to contribute something to the solution of the problems here mentioned and others of like nature too numerous to mention.

ADVERTISING GOOD ENGINEERING

The suggestion contained in the editorial in the November issue entitled: "Advertising Good Engineering" has received favorable comment. It was suggested that a fund be raised with which to purchase space in a popular magazine of large circulation and to use this space in educating the public to appreciate the money-saving possibilities of good engineering. It was further suggested that the fund be raised by subscriptions from engineers and engineering firms through the National Headquarters of the American Association of Engineers.

Typical of comment received on the suggestion is the following quotation from a letter from an engineer very high up in the municipal engineering service of the city of New York:

"Your editorial in the November issue regarding advertising the engineer has re-

ceived favorable comment from members of the Municipal Engineers of the City of New York. There seems to be a growing tendency on the part of engineers to adopt modern business methods for their own welfare, and indirectly what we believe will be the welfare of the community.

"As suggested by you, advertising in one of the largest publications or one of the most widely circulated magazines would probably bring the quickest results. However, before finances for such a campaign could be obtained, it would probably be necessary to do considerable advertising of the 'benefits' among the engineers themselves."

Another correspondent suggests an idea must "germinate" for a considerable period before it can be expected to bear much fruit.

This magazine will devote as much space to the advancement of this idea as engineers may consider advisable. We have agreed to devote a page in each issue, in the advertising section, to the task of selling the idea to engineers if some properly constituted body will utilize that space consistently in carrying out the details of a properly prepared plan for raising funds.

THE DICTATED ARTICLE

Engineers have often been urged, in these pages and elsewhere, to dictate short articles for publication, giving specific information of a practical nature. Receipt of such an article for use in this issue again reminds the editor of his enthusiasm over the possibilities of the dictated article.

The editor has received so many favors from the hands of contributors that he does not want to be understood as critical of articles that are written; his concern is over articles that might so easily be written but which the busy man does not find time to write.

Some articles require a vast amount of thought in their preparation. The amount of this thought depends on many things which it would serve no good purpose to enumerate. Suffice it to say that it does take a good deal of time, thought and effort to write certain classes of articles. But the article most wanted by readers is the short article, giving practical, up-to-date information and, unfortunately, the man in position to prepare such articles lacks the time to write them, or thinks he does which amounts to the same thing from the standpoint of production. The man in charge of a project has his head so full of details, both major and minor, and his time is so fully occupied in conferences and in other ways that he recoils from the suggestion that he write an article on his work while the work is in progress and when what he might give out would be of maximum value. Consequently he waits until the project has been completed and all the loose ends gathered up before he finds time to write anything. Then he writes ancient history from the standpoints of costs, labor conditions, material supply, transportation, etc. How unfortunate it is that he could not tell how he solved these changing problems from time to time while he was bearing their burden!

The dictated article is an easy and satisfactory solution of this problem. Men are seldom too busy to dictate a few letters each day and, while dictating, the engineer or contractor could get certain thoughts, impressions, facts and figures pertaining to his work, down on paper as a preliminary to giving this matter out for the use of his contemporaries. If the busy engineering executive will spend five minutes outlining the high spots on a particular job and another fifteen minutes in dictating a story based on his outline his stenographer and the magazine will do the rest.

The habit of dictating articles if at all generally practiced would revolutionize engineering journalism and would greatly increase the usefulness of engineering publications to their readers. We hope, since the season of good resolutions is at hand, that every reader of this editorial will resolve to dictate at least one short, practical article for this or some other publication for the year 1923. If this is done the construction industry will have made an important forward step.

By way of illustrating the value of the dictated article we respectfully refer the reader to the article published on page 245 of this issue entitled: Hints on Haulage of Lean Mixtures of Concrete. The author of the article has rendered a valuable service to all interested in road and street construction and he was able to do so only by having recourse to the dictated article. While this article was not dictated during construction it was *dictated* and, we submit, illustrates the very great practical value of short, dictated articles. But for previous suggestions along these lines the article to which we refer would never have become availabue for publication.

Methods Employed on Difficult Road Construction on Ozark Trail Highway in Eastern Arkansas

Swampy Soil Made Work Unusually Difficult—Drag Line Excavators Make High Fills—Special Attention to Drainage

By Albert S. Fry, Treasurer, Morgan Engineering Co., 620 Goodwyn Institute Bldg., Memphis, Tenn.

The Ozark Trail Road Improvement District of Poinsett County, Arkansas, is now completing ten miles of road, a part of which has presented unusual difficulties in road building because of the swampy nature of the soil along the location of about two-thirds of the road. The new road extends from Marked Tree, on the east bank of the St. Francis River, southeasterly to the south line of Poinsett County, where it joins with an improved road leading to Memphis, Tenn., a distance of about 25 miles from the end of the Ozark Trail road. The road is a part of the interstate Ozark Trail Highway, and is classified as a primary road by the Arkansas State Highway Department. Part of the lands across which the road is built are overflowed at certain seasons of the year and at such times Marked Tree has in the past been cut off from highway communication with the territory to the east, particularly with Memphis. This condition resulted in a demand for a road which would give Marked Tree access at all seasons of the year with eastern Arkansas and Memphis. To meet this demand the Ozark Trail Road Improvement District was created by a special act of the Arkansas Legislature in 1919. The District embraces an area of 51,300 acres and includes the town of Marked Tree and several smaller towns.

Nature of Country Traversed

The country through which the road

CONSTRUCTING OZARK TRAIL HIGHWAY IN EASTERN ARKANSAS.
Clearing Heavy Growth of Timber from Right of Way, Blasting Stump in Background —Dressing Embankment with Fresno.

passes is typical alluvial valley formation. The road extends across generally flat lowlands, especially by low ridges into valleys bordering the principal water courses. The main streams, Tyronza River, Dead Timber Lake, and a large drainage canal are crossed by the road nearly at right angles. The lowlands are overflowed whenever the streams are at high stages and remain wet and swampy for considerable periods of the year, the complete draining of these lands not yet having been carried out. The two chief ridges are one and two miles wide, and rising to about 10 ft. above the lowlands, are elevated above high waters.

Design

In designing the new road, the grade of the embankment was desired to be above maximum high water. Gage records on St. Francis River at Marked Tree for a number of years were available and high water marks were obtained on Tyronza River and the other watercourses which the road crosses. After thorough study of the high water records and data, the crown grade of the earth embankment was fixed at a minimum elevation of about 1½ ft. above maximum high water. On the ridges where the location is over ground, which is above high water, the grade was generally raised above the ground surface to secure drainage for these portions of the road.

The road follows along the south side of the St. Louis and San Francisco railroad. The railroad embankment, built many years ago, was constructed high enough to be above the elevation of Mississippi River overflow water if the levees on the Mississippi River broke, and long trestle openings were left through the embankment to pass Mississippi River overflow water. Since the railroad was built the levees along the Mississippi River have been so strengthened and have so successfully withstood extremely high waters that the possibility of overflow is now considered remote. Accordingly, in designing the embankment for the Ozark Trail road, Mississippi River overflow was not seriously considered. The railroad embankment serves to cut off all drainage from the north except that which comes through the trestles.

The standard road cross section adopted for the embankment had a crown width of 24 ft. and side slopes of 1½ to 1. Slopes of borrowpits were specified not to be steeper than 1 to 1 and a minimum berm of 5 ft. was required between the edge of the borrowpit and the toe of the embankment. The standard cross section was adhered to during construction except where material was encountered, which had a tendency to slide and at such places the embankment slopes were flattened.

To provide for shrinkage, 10 per cent excess material over the net cross section was required where teams and scrapers were used and 15 per cent required where drag line excavators were used.

Embankment Construction

The contract for the construction of the earth embankment was let June 2, 1919, and active construction work was begun a few weeks thereafter. Contract unit prices were as follows: Embankment, 45 cts. per cubic yard, clearing $40 per acre, grubbing $160 per acre, and clearing and grubbing $200 per acre.

Approximately one-third of the length of the road was on the ridge lands, where the fills averaged from 1 to 2 ft., and the embankment averaged 8,700 cu. yds. per mile. Building the road on the ridges was not difficult, because the work was dry and the fills light. This part of the work was done by teams with scrapers and fresnoes.

The remaining two-thirds of the road, some 6.6 miles, were located through the lowlands, where the fills were generally from 8 to 10 ft. and where the embankment averaged 24,300 cu. yds. per mile. This part of the work was particularly difficult on account of the wet, swampy nature of the ground during several months of the year, the heavy timber growing on most of the right-of-way, and the heavy fills which had to be made.

Five dragline excavators were used in building the embankment across the lowlands. The work could have been done with fewer machines had it not been for long delays caused by high water, which made work impossible for several months. Two of the drag lines operated on caterpillar treads, two on skids and the other on trucks. The booms on all the machines were 35 or 40 ft. long and the buckets were ¾ or 1 cu. yd. capacity.

Material for the embankment was taken from side borrowpits and the machines were required to excavate to a fixed grade line in order to secure drainage. The problem of securing material was complicated because many old borrowpits from which material had been taken for the railroad fill adjacent to the road extended beyond the railroad right-of-way

line on to the right-of-way for the highway, and thus decreased the amount of available material for the road embankment.

Clearing Right of Way

Before the embankment could be started the right-of-way, where it was wooded, had to be cleared for widths of from 100 to 125 ft. The land along the ridges and some of the lowlands was cleared, but most of the lowlands was covered with a growth of very heavy timber, such as cypress, tupelo gum and other swamp trees. Stumps were required to be removed to a depth of 2 ft. below the finished roadway, and where the fill was not more than 2 ft. the stumps and roots were grubbed out. Under embankments more than 2 ft. high, the stumps were cut close to the ground surface and were not grubbed out.

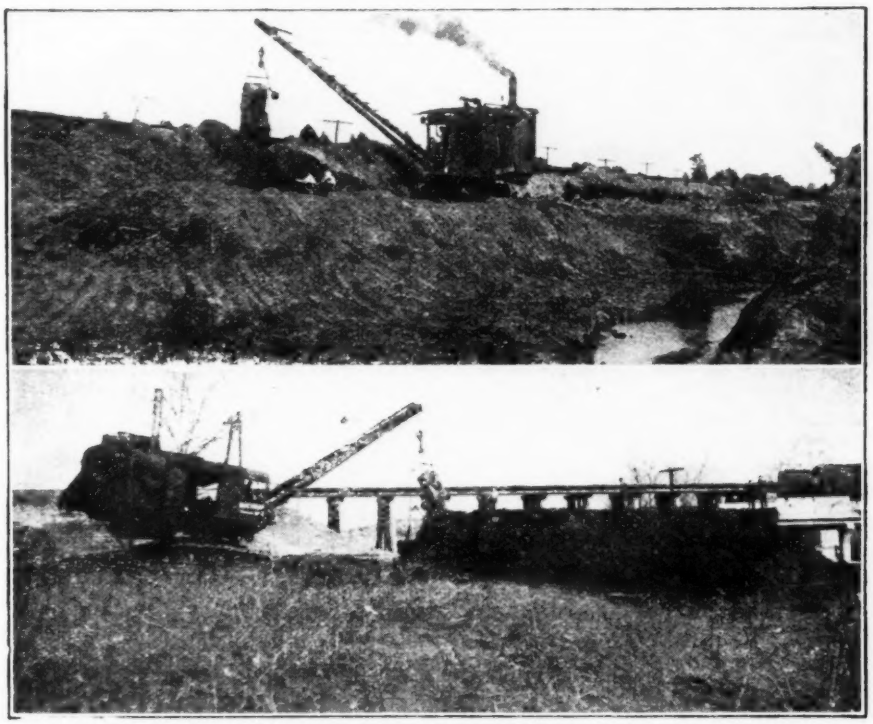
Hand labor and teams were used in cutting down the trees and snaking them off of the right-of-way. Stumps which had to be removed were blasted out by dynamite. Brush was piled and burned on the right-of-way.

Three of the dragline machines were installed on the work in July and August, 1919. At that time the bottom-lands were dry and it was possible to make good progress. One of the machines broke a main driving pinion a few weeks after starting work and was idle more than a month being repaired. In the early part of October, which is usually a dry month, very heavy rains occurred, which made progress very difficult. Water in the borrowpits made the digging slow and uncertain, and made it difficult to dig a satisfactory borrowpit ditch. The soft and slippery condition of the ground caused the machines to mire up and to slide off from their pontoons.

Winter Conditions

By November 1, water conditions had forced two of the draglines to shut down and by December 1 water covered the land where the draglines were working, so that it was necessary to suspend work for the winter until the water had receded from the land and the ground was dried out again.

Work was resumed again in March, 1920. In order to promote progress and complete the work before another win-



USING DRAG LINE EXCAVATORS TO MAKE HIGH FILLS ON OZARK TRAIL HIGHWAY CONSTRUCTION.

Top: Constructing 8 ft. Fill; Machine Triple Cutting from Borrow Pit to Place Material. Bottom: Constructing Embankment at Concrete Bridge Approach.

ter's high water, a fourth dragline machine had been built during the winter and was ready to work in the spring of 1920. One of the small draglines already on the job did not start until in July. A fifth dragline was put on the work to help this machine complete its section of the road. These two machines worked together until the completion of their work, one operating on one berm and the other on the opposite berm.

The fall of 1920 was dry and permitted work to be carried on until the end of the year by or before which time all of the dragline machines had finished the embankments. The embankment left by the dragline machines lacked much of being a finished road, and considerable work had to be done by teams or tractors with scrapers and graders in leveling off the fill and finishing up the roadway to an even crowned surface.

Performance of Dragline Machines

The five dragline machines placed 160,400 cu. yds. of earth in the road embankment. Of this amount one machine placed 53,200 cu. yds, another machine placed 35,700 cu. yds, and the other three machines each placed a little less than 24,000 cu. yds. each.

Where the depth of fill was not too great, the dragline machines set in the center of the road and excavating from both sides, built the whole road at one operation. Where the fill was too great for the material to be obtained within reach of the machine setting in the road, the excavator traveled along one berm, excavating from one side only and throwing up material for half of the road. The machine completed the fill by traveling back along the other berm. Two of the draglines were worked together on part of the work, one operating on one berm and the other on the opposite berm. Where the fill was highest and around the abutments of bridges, some material had to be rehandled one or more times.

The smaller draglines used were able only to throw up the dirt in much the shape of a spoil bank along a drainage ditch. Where the fill was heavy and required working down one berm and back the other, pockets were created between the fill thrown up on the first and second runs. Unless leveled off immediately after the second run of the machine, these pockets caught and held rain and the earth could not be worked over and leveled down satisfactorily until the material dried out.

Some of the machines had booms long enough to level off the earth immediately after it was placed, and so were able to put the correct amount of earth into the embankment to meet the required grade line without difficulty. Where the machine was not large enough to level off the fill, it was difficult for the machine operator to tell when he had the right amount of earth inside the slope stakes.

Part of the difficulties from water in the borrowpits could have been avoided had the work been started in all cases at the outlets for the borrowpit drainage ditches. Where this was not done the pits filled with water back of the excavator and the machine either had to excavate under water or leave a dam in the ditch to be removed at a later time.

Notwithstanding the difficulties encountered, dragline machines were probably the best means for constructing the work under the existing conditions.

A large part of the material from which the embankment was made consists of a stiff gumbo soil characteristic of the alluvial lowlands of the lower Mississippi valley. This material does not dig so easily as lighter soils, and is difficult to work in, but when finally settled, compacted and shaped into a roadway, it makes a very satisfactory embankment. On about 2 miles of the road, material was encountered which had a tendency to slide on slopes of 1½ to 1. On these parts of the work the embankment side slopes were increased to 2 to 1, borrowpit slopes to 1½ to 1, and berms 12 ft. wide were left between the edge of the borrowpit and the toe of the embankment.

One borrowpit draining into Tyronza River had to be refilled in order to prevent the fluctuating river water undermining the roadway. This pit was necessarily large in order to provide material for the high embankment required near the river, and every rise and fall in the river washed away some of the silty berms until the road embankment was endangered to the point where the pit had to be refilled.

The right-of-way for the road is immediately adjacent to the right-of-way line of the Frisco railroad, and one of the road borrowpits is between the railroad and the road. In some places the toe of the high railroad embankment approached closely to or even extended beyond the right-of-way line. In one such case, trouble was experienced with a slide in the railroad embankment after the borrowpit for the road had been excavated. The railroad fill settled vertically and

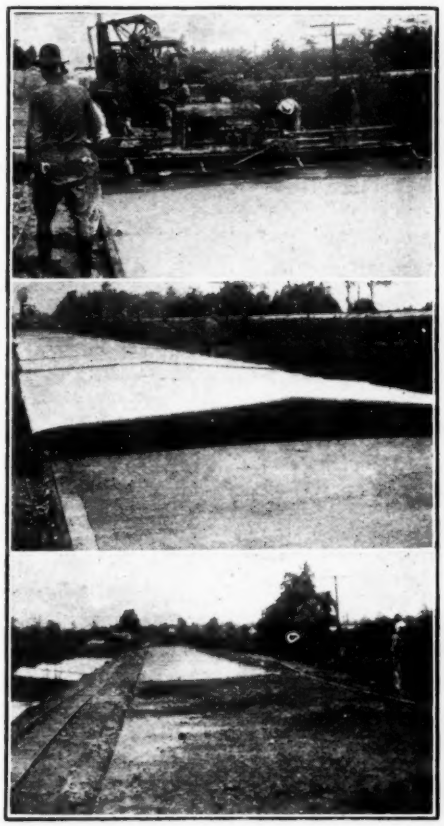
pushed out laterally into the highway borrowpit for several feet, blocking up most of the pit. After this slide occurred the highway was relocated wherever there would have been danger of further sliding, so that a safe berm remained between the toe of the railroad fill and the borrowpit ditch for the road.

Drainage

In constructing roads through country such as the Ozark Trail road traverses, good drainage for the roadbed is of utmost importance. Where it is necessary to build high fills by dragline excavators, the greater part of the material for the embankment must be taken from immediately alongside of the road. On the lowest ground, where the fill is greatest, the depth of cutting which may be allowed in the drainage ditches is least. In order to secure the large amount of material required to make the high fills, it is either necessary to make wide shallow borrowpits at such places or to excavate the material with the drag line at some other location and pile it up in the road where it can later be rehandled by teams and moved to the desired part of the road. It is difficult, however, to work over the top of an embankment fill made by draglines, and hence every effort was made to lay out the work so that material could be obtained from borrowpits immediately along each side of the road with a minimum amount of rehandling. This resulted in variation in the width of the borrowpits in order to obtain sufficient material for the embankment and still excavate only to the fixed grade line. This was necessary, however, in order to give good drainage to the embankment by the side ditches and to prevent holes, which would not drain out being dug where the cuts were greatest. There was always a temptation for the dragline operator to cut below grade and a large amount of education by the resident engineers was necessary to prevent this practice.

In addition to the actual drainage of the roadbed itself, another reason for requiring borrowpits to be dug so that they would drain was that it was desired not to create any artificial mosquito breeding places. In flat country wherever borrowpits are dug so that they do not drain out, the low places in the pits hold water and form excellent pools for mosquitoes, particularly the anopholes or malarial mosquito. A special effort was made on this job not to do anything that might promote malaria.

For cross drainage on the road Nelsen pre-cast concrete culverts were used These culverts are of horseshoe section, strongly reinforced, and are made in 2 ft. lengths. The 2 ft. sections were set in a reinforced concrete base which was poured in place. About 1,600 lin. ft. of 12, 18 and 24 in. culverts were used. For larged sized culvert openings conforming to the standards of the Arkansas State Highway Department, were used. These were poured in place.



CONCRETING ROADWAY ON OZARK TRAIL HIGHWAY IN ARKANSAS.

Finishing Concrete Surface with Machine After which Surface is Broomed Lightly—Protecting Green Concrete from Hot Sun with Canvass Frame—Covering New Concrete with Moist Earth.

Bridges

The bridges on the road were constructed at the same time as the embankment work. Six hundred lineal feet of bridges were required. Steel girders were used across the main water courses and concrete structures were used for approach spans to the steel girders and for the smaller bridges. All the bridges

have roadways 18 ft. wide and are designed for a loading of 15 tons. The main bridges were founded on steel cylinder tubes filled with concrete and supported on wooden piles driven under the tubes.

The longest bridge is 244 ft. this being across Tyronza River. This is made up of 2 steel girders, each 50 ft long, and 9 concrete spans, each 16 ft. long. For uniformity and ease of construction, all concrete bridges and approaches were designed in combinations of spans each 16 ft. in length.

Concrete Surface

Much of the material in the embankments being gumbo soil which compacts very slowly, holds water with great tenacity and dries out very hard, it was necessary for the high embankments through the low lands to settle for several months before a hard surface could be safely built. Embankment constructed by dragline machines is not compacted as much as where teams are used, and this was an additional reason for delaying the placing of the hard surface. The embankment was subject to traffic as an earth road until the summer of 1922, by which time the earth had settled and compacted into a stable foundation for a hard road surface.

A contract was let in July, 1922, for a concrete surface to be placed on the embankment. This work is now under way. The concrete roadway is 18 ft. wide, 8½ ins. thick at the center, 6 ins. thick at the sides, and the surface slopes ¼ in. per ft. The concrete is reinforced with metal weighing 0.4 lb. per sq. ft. A 1-2-3 mix is being used. Three foot shoulders will be built and maintained along each side of the concrete surface.

Central Proportioning Plant and Industrial Railway

The methods being used for constructing the concrete surface are not unusual. Materials are mixed at a central proportioning plant and are transported to the mixer by an industrial railroad. After the concrete is poured and finished to correct cross section, the surface is broomed lightly. Canvas covered frames are placed over the pavement as soon as it has been broomed. The pavement is then covered with earth, which is kept moist for several days. The road is opened to traffic in sections 30 days after pouring.

Car shortage has resulted in serious delays in completing the concrete surface, because it has been impossible to obtain cars for materials.

Cost

Because of the high embankments required across the lowlands and the length of bridges necessary in crossing the watercourses, the cost per mile of the road is high. The embankment work, including clearing and grubbing cost, $95,230, and the bridges and culverts, $50,520. that the average cost per mile for em- The exact length of road is 9.8 miles, so bankment was $9,700, and for bridges and culverts $5,150, the combined average cost per mile without the concrete surface being $14,850. The concrete surface is costing $28,500 per mile, so that the total cost of the completed hard surfaced road will be $43,350 per mile.

Funds for the work are provided partly by a bond issue, which is being repaid from taxation of the lands in the district, and partly from Federal aid, which was granted on the entire road.

Engineers and Contractors

The contractor on the embankment work was the McWilliams Company, Inc., of Memphis. The culverts were installed by the Nelsen Concrete Culvert Company of Jonesboro, Ark. The bridges were built by Larimer & Burget of Memphis. The concrete surface is being constructed by the Hansen Construction Company of Blytheville, Ark. Surveys and plans for the district were made by the Morgan Engineering Company, Memphis, Tenn., and all of the construction work has been carried out under their direction. Ned H. Sayford, Vice-President of the Morgan Engineering Company, has been in direct charge of all the engineering work.

THE INEVITABILITY OF THE ST. LAWRENCE ROUTE TO THE SEA

By Francis C. Shenehon, Consulting Hydraulic Engineer, 628 Metropolitan Bank Bldg., Minneapolis, Minn.*

The St. Lawrence Waterway, destined to create an avenue for deep-draft vessels between the fresh-water seas of the Great Lakes and the salt-water seas encircling the globe—this waterway has been so much discussed in many addresses, in many magazines and in the public press, that the general features of it do not need further amplification or explanation here.

Perhaps at the present time, with a lull in the battle between those strenuously

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advocating this waterway and those strenuously opposing, it may be helpful to state, with some positiveness, the reasons why the obstruction of the opponents of this route is certain to be futile, and why the waterway itself will persist and become a fact.

The need of deep-draft connection between the Great Lakes and the salt seas has been long recognized. In a report made in 1897 by a distinguished board consisting of the then President of the University of Michigan, Dr. James B. Angell, John E. Russell and the well-known hydraulic engineer of that time, Lyman E. Cooley, recommendations were made for an extensive investigation of the various routes to tidewater which appeared to have any measure of practicability. The contemplated waterway was solely for navigation, because at that time water power appeared to be something that tended to block the enterprise because it must be condemned and paid for to get it out of the way; or else the navigational scheme must adjust itself to the existing water power situation at some cost.

The routes recommended for investigation by the earlier Commission were all focused on New York as the portal to the Great Lakes System, or as the port of exit into salt water. It is not probable that patriotism alone was the controlling element in this emphasizing of an American-Atlantic seaport as the outbound terminal for lake navigation. It was simply the fact that water power consciousness had not fully emerged.

The need of development of a great energy resource such as the St. Lawrence River was not clearly apparent, nor was the market for this power at that time available. In fact, now, a quarter of a century later, many engineers and investigators of the St. Lawrence route do not clearly visualize the market which will exist for all obtainable energy at the end of the period of incubation for the St. Lawrence waterway and the years necessary to its construction. The writer ventures the prophecy that ten years hence, or by 1933, a visible market will exist for the fullest development of the water power of the St. Lawrence River.

It must be understood that under the Federal Water Power Act, licenses are issued for water power use on streams coming within the jurisdiction of the Federal Government for a term of 50 years. Such a lease beginning in 1933 will continue to be in force until 1983, and then possibly renewed. It is a daring pessimist who fails to visualize the vast strides being made in electric current use in domestic life, in the arts and in the industries, as the years go by—not alone by reason of population growth, but by reason of the intenser use of electricity itself in all the phases of domestic and business life. The electric furnace alone, a tremendous absorber of cheap electric energy converted into intense heat, will utilize great blocks of power.

The writer, while he believes the St. Lawrence Waterway to be primarily a great navigational project, prefers to emphasize the water power element in this discussion, because it is the water power itself which must determine the preponderating desirability of the route of this necessary navigational avenue to the sea.

Other avenues—which are international in part, or all-American in full—exist, all of which focus on the port of New York. An all-American route follows the line of the present barge canal, leaving Lake Erie at Buffalo and entering the port of New York through the Hudson River. Another route departs from Lake Ontario at Oswego, N. Y., climbs up to the level of the barge canal and proceeds by the same route as mentioned above to the Hudson River and tidewater at New York. Other routes proceed down the St. Lawrence and then across to Lake Champlain and on to the Hudson River and the port of New York. These routes have, so far as the canalized portion of them is concerned, the vital defect of slow movement of vessels as compared with fast steaming through an open waterway. This means the loss of time by costly vessels with increased freight cost due to this time lost in transit. It means also that no adequate monetary assistance in the project itself will come from a partnership with water power which may bear a portion of the capital cost. Here, it will be observed, are two vital defects.

In demonstrating the inevitability of the St. Lawrence route, the writer wishes to set down as the first proposition: *The economic desirability of deep-draft connection between the Great Lakes and salt water is so obvious that it is axiomatic.* It is for this reason that Congress in 1897 followed the recommendations of the Angell-Russell-Cooley Commission, already referred to, and appropriated nearly half a million dollars for a thorough engineering investigation of the various routes between the Lakes and tidewater. As before stated these routes debouched into

the Atlantic through the port of New York. The personnel of this commission of engineers appointed by the President to carry out the purposes mentioned was so distinguished that the conclusions reached by these engineers must be given the highest weight. These engineers were Col. Charles W. Raymond, Alfred Noble and George Y. Wisner, and the report made by this Commission in 1900, after two years of work, is a monument of investigation and judical conclusions. Only 23 years later, in this day of intense electric energy use, it is interesting to note the fact observed before—that water power as a co-ordinate development did not substantially enter into any of the projects recommended.

In discussing the inevitability of the St. Lawrence Waterway to the Sea, the second proposition is: *The full use of the energy of the St. Lawrence River is an economic necessity which cannot be permitted to lie unused.* In this stream four million electric horsepower are awaiting the command of the people of two nations to take up innumerable tasks, to assume innumerable burdens which now rest upon human shoulders, to illuminate the night and make to blaze countless electric furnaces. These will produce steel, malleable iron castings, ferroalloys now so necessary in the arts, aluminum, graphite, fertilizers, carbide, carborundum, bleaching powder and various other desirable commodities. It is simply unthinkable that one of the most opulent power resources in the world should long remain unused at a time when the usable power in the Niagara River has reached—and possibly exceeded—the limits of the treaty agreed upon with Great Britain; at a time when a distinctly inferior water power on a flood stream at Muscle Shoals is being fought for with avidity—it is simply unthinkable that this vastly superior energy resource of the St. Lawrence River should remain unused.

In discussing the inevitability of the St. Lawrence River Waterway, the third proposition is: *The route where both water power and navigation co-exist is the logical and certain route from the inland seas to the salt seas.* In other words, the way the water goes to the sea is the way navigation must go also. The water power cannot be developed without developing navigation as an incident, and navigation, itself the paramount thing, cannot be developed without incidentally creating great water powers. What the writer has been endeavoring to show is briefly this: The eternal forces of Nature, operating geologically, have already carved and fixed the pathway to the sea, and in this pathway the vast volume of the surplus waters of the Great Lakes outflow; and it is inevitable that commerce must take the same route.

What are the obstacles which temporarily delay this inevitable thing? First, the fact that geological forces in carving the channel of the St. Lawrence River made two nations proprietors of the channel. The St. Lawrence River for only a portion of its length is an international boundary stream; the river then departs into Canadian territory as it continues its descent over the rapids to Montreal, and then through the deep wide channel of the lower river passes to the Gulf of St. Lawrence. Two nationalities mean the need of treaties which will determine the proprietorship and conditions of use of the vast volume of electric energy to be produced. The question of navigation, so far as the dual nationality element is concerned, has no great substance as a deterrent for this particular route. Under existing treaty provisions, free and unrestricted use of the St. Lawrence River and of the Great Lakes on equal terms is accorded to each nation without discrimination as to whether the channel lies in American or Canadian waters.

Much more intense than the element of internationality is the element of provincial or state or some other group opposition which may find in this waterway to the sea a possible local loss. It is quite easy to see why New York State, so far as the navigational element is concerned, should not wish to see commerce avoiding the port of New York; but, on the other hand, New York State, within a distance of one to two hundred miles of the St. Lawrence River, will be the chief American beneficiary of the electric energy to be produced. The State of New York has therefore a divided loyalty in the matter of this waterway project—a desire to have the energy of the water power development, and a desire to keep all possible commerce threading through the port of New York, which is antagonistic to a water power development on the St. Lawrence, if it become also a great deep-draft waterway. Montreal, as the terminal for up-bound ocean traffic, with all the profitable business of transfers between ocean carriers and rail, cannot—with human nature such as it is—view favorably vessels flying the flags of

all nations passing by her wharves without contributing to the business prosperity of her port. Buffalo hates to lose this desirable business—which really represents to the nation at large economic loss—of cargo transfers from lake carriers to railroad cars or to canal boats.

It has been said that the project to create a single union station for all railways in a great city is not favored by the baggage and passenger transfer companies enjoying the business of these transfers. An undertaker might not look favorably upon a purified water supply, which might interfere with his business.

In the end the international element will find a solution. The opposition coming from local interests, as opposed to the interests of the people as a whole, will dissolve by the very futility of endeavoring to obstruct a thing which all economic considerations point out as right. For those interested in obstruction, the best to be expected is some temporary delay, for the waterway of the St. Lawrence is the way the water goes, and it is therefore the way that commerce also must inevitably go.

STEAM AND HEAVY OIL COMBUSTION ENGINES FOR MUNICIPAL SERVICE

By John W. Hill, of John W. Hill & Sons, Consulting Engineers, 45 Bodmann Bldg., Cincinnati, Ohio.

The superiority of the heavy oil engine, in point of fuel efficiency, for small and moderate powers has been amply demonstrated, and its substitution for steam power in municipal service in cities of 25,000 population and less, will result in such a reduction in operating cost as to justify the abandonment and scrapping of many of the smaller plants, and their replacement by more modern equipment for pumping water and sewage and for generating electric current.

There are many situations where the substitution of the oil engine with direct driven or geared pumps, either turbine, centrifugal or plunger pumps, will within a short period of operation effect a saving in fuel charges sufficient to cover the cost of new equipment, and eventually provide a fund for other improvements or lower the charges for service.

Aside from improved fuel economy the oil engine has the further advantage over steam power of the absence of boilers under pressure, and all the hazards and trouble and expense connected with them. The smaller space required for a complete power plant and its cleanliness and conveniences are also arguments in favor of oil outfits when compared to steam.

As a rule the fixed charges, interest and depreciation are larger for the oil engine power, and the item of oil for lubrication is also larger. Information on repairs and general upkeep is not so satisfactory as on other items, but according to the British reports the oil engine can in this respect hold its own with steam.

Simplicity favors the oil engine, all the requisites being combined in a single machine, while the steam engine, whatever form it may take, requires a steam boiler, and for best results a superheater, feed pumps, feed water heaters, fuel economizer possibly, and a towering chimney.

One room will accommodate the oil engine and this need not demand more floor space than the equivalent steam power, while two rooms are required for a steam power plant.

When electric current can be obtained at low rates its convenience and cost of service will make this the most desirable. In fact, it is the ideal power for municipal service even if required for large units, and water power used direct or electrically from a well developed source will usually supply municipal needs at lower cost than steam or oil engines. But the great majority of the smaller cities and towns are so located as to be beyond the reach of cheap power, excepting it can be developed at home, and the strictly local controllable sources of power generally speaking are the steam engine, the oil engine and the gasoline engine.

The cost of fuel, coal, oil and gasoline, in any locality, and to a certain extent the size of power required, usually determines the matter.

Power for municipal service, must from reasons of prudence always be considered in duplicate or rather be so designed that the service may not be interrupted or impaired by the shut down of any one unit, and where one unit is of sufficient capacity to carry the whole load, then at least another unit of equal capacity must be provided, so that the patrons must not at any time be deprived of the service; because, generally, they are wholly helpless in case of interruption or impairment of service. This may seem to be a self evident fact, but even some large and well organized cities have suffered inexcusable interruptions of public power service at frequent intervals, so that when

a city or town undertakes to supply a public service of any kind, it must be prepared to do it continuously without interruption and at the least cost to the citizens, all things considered.

This article is written to impress upon public officials the importance of serious thought of oil engines as a source of motive power, but it cannot be assumed that there are no drawbacks to the use of the oil engine in place of the steam engine. The consumption of lubricating oil for the oil engine is much larger in quantity than for steam engines and forms a significant element of operating cost. The cost of repairs and maintenance is said to be larger for the oil engine, and these adverse conditions must not be overlooked in comparing operating costs. If the cost of fuel, coal and oil or their equivalents, was constant for years everywhere or anywhere, then a definite relation between the operating costs of these two kinds of power could be established. In a locality where, or at a time when, coal is cheap and oil is dear the question is promptly decided in favor of the steam power, and of course converse conditions favor the heavy oil engine. In establishments where considerable steam or steam heat is required, the steam engine usually seems to fit the conditions best.

The lack of natural gas in all but a few favored localities, and the price and lower B. T. U. for artificial gas naturally limits gas engines in the aggregate to a small field and small capacities, and gasoline at current prices has become impossible for the development of continuous power of any magnitude. During the past 25 years the Diesel oil combustion engine has undergone wonderful improvement and a type of oil engine known as the Semi-Diesel has been developed to a high fuel efficiency.

With the oil combustion engine there are no stand-by charges, when the engine stops the consumption of fuel stops, and no fuel is used until the engine is started in service. Not so with the steam engine, much fuel is used in warming up the boilers and furnaces, in starting and raising steam to working pressure, and in banking fires, and that burned out on the grate after the power is shut down, all of which must be considered in arriving at the fuel cost of power.

The cleanliness and convenience of the oil combustion engine is obvious.

It may be said that many important steam installations are dependent on heavy oil for fuel, notably the marine service, some of the latest and largest ships being supplied with oil burners under the steam boilers. Oil is also largely used in locomotives and in factories for steam where conditions favor it, and no proposed installation of motive power is halted for fear of the early prospective loss of heavy oil as a power fuel. Keep in mind, however, that if crude oil is used for generating power, it will give a higher efficiency in the combustion chamber than it will under a steam boiler.

Small or moderate powers for municipal service, pumping water or sewage or generating electric current, are now usually obtained from steam, gas, gasoline or oil, and rarely from water power, because commercial water power today is generally converted into electric current at its source, and conveyed to users through the well known wire conductors, and is so used in many instances for pumping water and sewage in municipal service. Water power used direct for pumping municipal water supplies in the early history of water works in this country was found in Fairmount Sta., Philadelphia, Pa., Indianapolis and Ft. Wayne, Ind., Rochester and Lockport, N. Y., Middletown, Troy and Piqua, Ohio, and many other places in the East and Middle West, where such power was available.

Many early water works operated by water power were supplied with steam machinery for auxiliary purposes and for emergencies, and in due time steam pumping machinery came almost into universal use for municipal pumping. In the larger cities no other power was available 25 years ago, and the High Duty compound and triple expansion pumping engine has attained and holds a high degree of economy in cost of operation.

For small cities of moderate power requirements steam engines have not been economical in fuel consumption and necessity has been the prime factor in promoting the substitution and use of oil, gas and gasoline power for this service. Aside from reduced operating costs, the absence of steam boilers, boiler rooms, stokers, feed pumps, feed water heater, and other necessary adjuncts of a steam outfit, together with lower first cost has recommended the use of gas and gasoline power in place of steam power. Gas has a more limited application than gasoline because the latter is not universally available and gas engines are seldom used outside the radius of distribution of natural gas.

Artificial gas is, however, also used, and

is convenient if not economical for small requirements where natural gas cannot be obtained.

In comparing the costs of steam and oil power, the fixed charges or interest and allowance to a reserve fund, sufficient, either by the sinking fund method or otherwise, to discharge the original investment at the end of the useful life of the machine, or combination of machines, should be taken on at least two units of the power service, either of which must be capable of easily maintaining the service. While the operating charges regardless of the number of power units will always be figured as the cost of furnishing the service, wages, fuel, repairs, etc. To be exact the item of water consumption for steam power, and for cooling purposes for oil power should be considered in comparing operating charges.

If the service requires two or more power units to maintain it, then one additional unit of capacity equal to the largest unit which may go out or be taken out of service must be considered in arriving at the item "fixed charges" in power cost. In small electric and pumping works for water or sewage this usually means that the power machinery will be in duplicate.

The frequency of strikes in the coal fields, and accompanying high prices of coal, and difficulty in obtaining it, naturaly suggest other sources of motive power than steam, where these are available. Oil can be transported as broadly and conveniently as can coal, and wherever railroads, steamboats or motor trucks can deliver coal they can also deliver fuel oil. The price of fuel oil is not fluctuating like the price of coal, and a power user can therefore figure with more confidence on his fuel cost than if coal were the fuel used. It might be urged that coal is a more certain power fuel through a long period of time in the future, but the prospect of heavy oil and other fuels adaptable to the oil engine gives this source of power a probable life sufficient to cover all hazards of fuel exhaustion during the useful life of the motor.

Coal and oil as fuel for power can be readily compared in any locality upon the following basis, prices being changed according to location.

Assume steam coal at $5 per ton, heat value at 12,500 B. T. U. per pound of coal; then 1,000,000 B. T. U. will cost 20 cents.

Assume heavy fuel oil costs 5½ cents per gallon, heat value 18,500 B. T. U. per pound of oil, and weight 7½ lbs. per gallon; then 1,000,000 B. T. U. will cost 39.5 cents.

This shows an oil cost of twice the coal cost, but the relative fuel efficiency for the oil engine will be more than 2 to 1. It may be in many existing instances for small powers 6 or 8 to 1, so that with steam coal at $5 per ton and fuel oil at 5½ cents per gallon, it can safely be assumed that the heavy oil engine will be the best investment.

This does not take into account the increased cost for the oil engine of lubricating oil, grease and waste, but if this cost should be as much as 15 per cent of the combined cost of fuel oil and lubricating oil, etc., there will still be a relative fuel efficiency in favor of the oil engine of 5 to 7 to 1. Dividing these figures by 2, the relative fuel costs, there is a final fuel efficiency and fuel costs combined, of 2½ to 3½ in favor of the oil engine.

The heat efficiency of a large vertical triple expansion crank and fly-wheel pumping engine, showing a test duty of 200,000,000 ft. lbs. per 1,000 lbs. of high pressure superheated steam, equivalent to about 1 lb. of high grade coal per I. I. H. P. hour, is about 33,75 per cent of the B. T. U. in the oil.

The heat efficiency of a heavy oil combustion engine of the Diesel type of 150 to 250 BH. P. with fuel oil of 19,000 B. T. U. per pound, and consupmtion of ⅜ lb. per H. P. hour, is about 35.75 per cent of the B. T. U. in the oil.

But this relation is shown between a small capacity heavy oil engine, of which there are many, and a large high duty pumping engine, of which there is only one or perhaps two. As it is, on the data assumed, the power cost of fuel per I. H. P. is about in balance.

There are several hundred horizontal duplex direct acting steam pumps, many compound, some condensing, now in daily municipal service, showing heat efficiencies of five or less per cent of the B. T. U., in the coal expended in developing the pumping power, which can be displaced by heavy oil combustion engines, driving geared duplex or triplex pumps, or centrifugal pumps with a saving in the cost of fuel sufficient to pay for the new outfit within a few years, and thereafter be a source of saving for other necessary improvements.

In comparing steam and oil engines for small powers, there is to be considered the relative fixed charges on the cost of

installation, and in this must be included all items necessary to the completion of the equipment. Account must be taken of the useful life of the engine and its adjuncts in order to determine the time to run an annual allowance for redemption charges. If the plant is a new one and comparison of investment costs (steam and oil) is properly made, it will be often found that the cost of the oil engine complete, including the heavy foundations, will be less than the cost of the complete steam equipment.

NEW WATER SUPPLY SYSTEM AT BRAINERD, MINN.

By George M. Shepard, Associate with Louis P. Wolff, Consulting Engineer, 1000 Guardian Life Bldg., St. Paul, Minn.

While improvements in water supply systems in cities of 10,000 population, the size of Brainerd, Minn., may not generally be of unusual interest, there are some features of this system which are of interest to municipal engineers.

The original water works system in Brainerd was constructed by a private company. In 1909 the plant was purchased by the city of Brainerd from the Minnesota Water Works Co., and since that time has been operated by a Water and Light Board. Shortly after taking over the plant the old station burned and the mains, which under private ownership had been largely constructed of kalomine and wrought steel pipe, began to develop a considerable amount of leakage. It became evident that the city would soon have to undertake the construction of practically a new system. Such a proposition was considered a number of times between 1909 and 1917, but was delayed on account of the war.

During the latter part of 1918 Mr. Louis P. Wolff, Consulting Engineer of St. Paul, Minn., was employed to make an investigation, report and estimate of the cost of a water works system which would meet the requirements of the city. Under the direction of Mr. Carl Zapffe, a geologist, President of the Water and Light Board, a great number of borings were made in the vicinity of Brainerd in an effort to locate a suitable well supply. A gravel bed yielding a water of excellent quality was eventually located in a flat bordering the Mississippi River directly southwest and within the city limits.

The Consulting Engineer's report, after giving careful consideration to a lake supply from a distant source, a filtered water supply and a well supply from the gravel formation just mentioned, recommended the well supply both on account of its proximity and lower cost, also the rebuilding of the water main system, the construction of a storage reservoir of 800,000 gals., and an elevated tower and tank of

FIG. 1—REINFORCED CONCRETE WATER TOWER AND TANK AT BRAINERD, MINN.

300,000 gals. capacity, together with high service centrifugal pumps, with gasoline engine auxiliaries for fire service, in addition to the two 6-in. motor driven centrifugal pumps then in service.

A bond election for the sum of $300,000 was placed before the people in the early spring of 1919. Following an interesting educational campaign upon the general subject of pure water supply, the bond election carried by a large majority.

The contracts were let for the various items of the work during July, 1919, the city buying the cast iron main and pumping equipment f. o. b. cars and laying the mains, installing the machinery and sinking the tubular wells by its own forces.

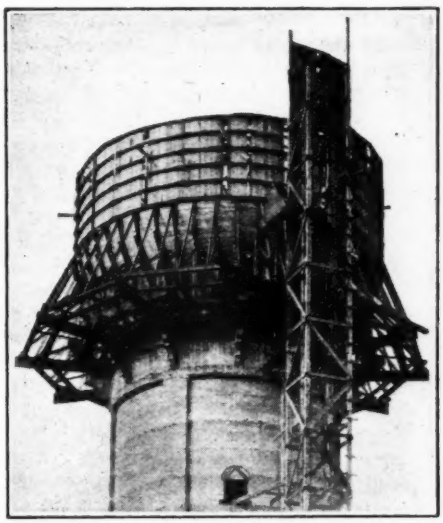


FIG. 2—FORMS FOR CONSTRUCTING LOWER PORTION OF BRAINERD, MINN., CONCRETE WATER TANK.

The supply is derived from two groups of tubular wells and one reinforced concrete open well 40 ft. in diameter, each of the groups and the open well being equipped with a low service centrifugal pump for discharge to the reservoir. A sufficient area was purchased by the city to allow for the extension of the well system indefinitely to provide an increased supply. Well group No. 1 consists of four 8-in. wells 91 ft. deep, with 15 ft. screens, these wells being connected to the suction of a vertical motor driven centrifugal pump set in a well pit at the junction of the lines connecting the four wells. Well group No. 2 consists of three 8-in. wells 72 ft. deep, with 12 ft. screens and one 8-in. well 105 ft. deep, with 36 ft. screen. The yield of well group No. 1 is approximately 700 G. P. M., of well group No. 2 approximately 900 G. P. M. and of the open well approximately 800 G. P. M.

For the elevated tower and tank bids were received on both a steel and concrete tank of 300,000 gals. capacity on a 90 ft. tower. The bid for the concrete tower of the design shown in Fig. 1 was $28,574 by W. S. Hewett of Minneapolis, Minn., while the bid for the steel tank was approximately $25,000. In view of the fact that the tower was located in the central portion of the city and it was advisable to provide a structure of as ornamental design as possible, the concrete tower and tank was selected. The concrete tower and tank, with footings complete, contains approximately 1,000 cu. yds. of concrete. The height of the tower is 90 ft., and of the tower and tank combined is 134 ft. from ground line to top. The tank proper above the bowl is 40 ft. in diameter and is supported by two concentric rings of concrete, the inner ring 8 ft. in diameter and the outer ring 31 ft. in diameter. The new structure is of reinforced concrete, the side walls of the tank having a thickness of 12 ins. Fig. 2 shows the forms for constructing the lower portion of the tank.

The pumping equipment consists of two 6-in. Allis-Chalmers pumps, which were moved from the old plant, and two new 6-in, 3-stage horizontal Midwest-Hill pumps. The 6-in., 3-stage pumps are for

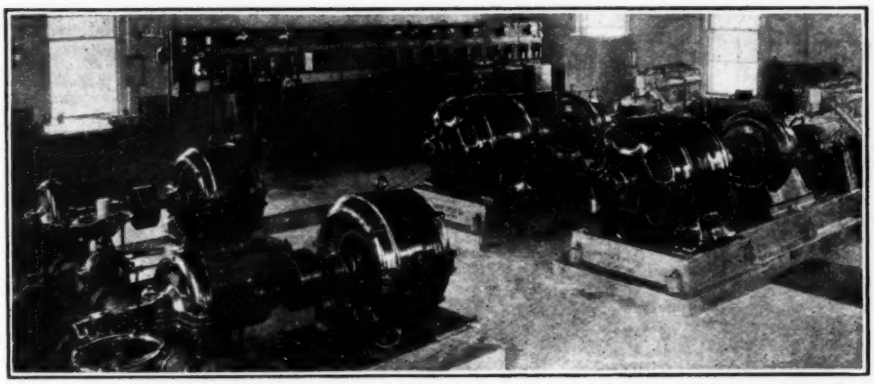


FIG. 3—INTERIOR OF PUMPING STATION AT BRAINERD, MINN., SHOWING SWITCHBOARD AND MOTOR DRIVEN CENTRIFUGAL PUMPS.

fire service and are rated at 1,000 G. P. M. each, against a total head of 275 ft., each pump being connected at one end to a 125 h. p., 3 phase, 2,200 volt, induction motor, and at the other end to a 136 h. p., 6 cylinder Van Blerck gasoline engine. Space is provided in the station for additional domestic and fire service units. The transmission line is run to a bus bar in the rear of the switchboard in the station, from which connection is made to the various units. Both the domestic and fire service pumps in the station and the low service pumps at the well groups are controlled from the station. Fig. 3 shows the interior of the station, with pumping equipment and switchboard.

The new system has been in operation since the early summer of 1920. Mr. Louis P. Wolff was Consulting Engineer on the above work, with Mr. R. T. Campbell, City Engineer, acting as Resident Engineer.

PRACTICAL SIGNIFICANCE OF SOME ROAD MATERIAL TESTS

By F. H. Jackson, Senior Assistant Testing Engineer, Bureau of Public Roads, Washington, D. C.

In the following discussion the writer desires to call to the attention of engineers who may not be particularly familiar with the technique of highway materials testing some points which should be borne in mind when interpreting the results of test data. It is frankly from the standpoint of the testing engineer, and is based on experience in this field, insofar as non-bituminous materials are concerned for a period of about 15 years.

The art of testing road materials has by no means attained the perfection of an exact science. Some of the tests now in use were first proposed and adopted many years ago when the necessity for adequate premliminary research was not realized quite so much as it is today. The result is that certain tests have been firmly established by custom and long usage, which are admittedly weak in some particulars. The so-called Deval abrasion test for rock and the "tensile strength ratio" determination for concrete sands are typical examples. Because these tests are not technically perfect, however, is no reason why they should not be used. They can be made to serve a very useful purpose, provided the engineer understands wherein the tests are weak and makes due allowance therefor in his interpretation of the results.

The very rapid changes within the past few years in the design and types of pavements in use, caused by changes both in the volume and character of traffic, likewise continually call for modifications in testing methods to meet new conditions. As an illustration of this point, the cementation test for rock may be cited. This test was used quite extensively in the days of water-bound macadam road construction, but is now practically obsolete. The standarization of tests is at best a slow process, and when one considers the frequency with which new conditions arise, it is not surprising that some of our methods of tests have failed to attain the perfection which certain critics seem to expect.

Another point which is overlooked frequently in studying test data is the question of availability of material. Although this is a matter primarily for the specification writer, experience has shown that many specifications contain requirements which cannot be met with any available material. It is well, therefore, that the engineer be familiar with the range in quality as shown by test results of all materials which could compete with those which he is examining.

Looking at the proposition from another angle, a third essential requirement is that he be familiar with service results obtained with materials similar to those in which he is interested. This particularly applies to such naturally occurring products as rock, sand, gravel, etc. The proper selection of such materials in any case can only be made by studying the test data in the light of all of the service indications which it is possible to obtain. Likewise, in the examination of tests of manufactured materials such as Portland cement, paving brick, etc., it is desirable that the engineer know something of the previous service and characteristic weaknesses, if any, of the particular product he is investigating. For instance, he may know of a certain mill which may be grinding cement so as just to pass the specifications. He will naturally scrutinize results of fineness tests on this product more carefully than where he is reasonably sure from past experience that the mill is well within the limit.

It will be seen from the above that to pass judgment intelligently on the results of laboratory tests is not quite so simple as might be supposed. Summing up briefly, anyone who would make the best use of such information must know enough about the methods of tests em-

ployed to be able to apply reasonable tolerances, he must be familiar with the general character and range in quality of all available materials, and he should know something of the previous service rendered by similar materials in the type of construction involved.

A brief discussion of some of the more commonly used non-bituminous road materials along the lines suggested above follows:

Portland Cement

Portland cement is probably the most universally used of all of the manufactured materials employed in the construction of roads. There is hardly a street or highway of any kind built in which cement is not used, either in the base or surface course of the pavement or in the construction of drainage structures, curbs, etc. The present requirements of the Bureau of Public Roads specify that all cement used in Federal Aid construction must be tested regardless of the amount involved. Practically all Portland cement is now manufactured under the specifications and is tested by the methods prescribed by the American Society for Testing Materials. Several years' experience in testing this material has convinced the writer that, although these methods of tests are far from perfect, they are sufficiently accurate when properly conducted to detect inferior cement. The words "properly conducted" are used advisedly because there are many laboratories which are unfortunately carrying on routine tests of cement in an incorrect manner. Throughout this paper, however, it will be assumed that the laboratory methods in use conform to the best practice, and that what variations in results are obtained are due rather to inaccuracies in the test itself than to carelessness or ignorance on the part of the laboratory. The present specification limits for Portland cement have been set so low, particularly as regards tensile strength, that there should be no difficulty for any standard brand properly manufactured to meet the requirements. For this reason the writer would be inclined to adhere rigidly to the present American Society for Testing Materials' requirements, except possibly in the case of the fineness test, where a 1 per cent tolerance is permissible to cover unavoidable variations in testing.

In thin connection it is well, in interpreting fineness test results, to be sure that a standardized cement sieve is used. Cement No. 200—mesh sieves now on the market are apt to vary as much as 3 per cent from the true value. All reports of fineness tests should indicate that the result has been corrected and should give the correction factor. The United States Bureau of Standards will standardize cement sieves for a nominal charge. Results of tests for time of set are usually well within specification limits. Due to the large personal equation involved in this test, no significance should be attached to variations within the limits. About the only value the test has is to detect a flash set. If a flash is reported, however, the cement should positively not be used until it has been thoroughly re-tested and found to be O. K. A word also about the soundness test may not be amiss. A mere report of unsoundness by the laboratory is not sufficient cause for rejection. Unsoundness is caused by the hydration of an excess of free lime, which produces distintegration in the cement by reason of its increase in volume. If a cement showing such unsoundness is stored for a period of two or three weeks prior to use, the chances are that the lime will air slake and thus become inert. Cements therefore which are unsound when first tested should always be held for a sufficient period to allow this slaking to occur, after which they should be retested, and if sound, accepted for use.

Concrete Aggregates

The strength and durability of concrete depends fully as much on the character of the aggregates used as on the quality of cement. For this reason a number of tests have been devised and requirements established for both fine and coarse aggregates for the various types of construction.

Fine Aggregates

Fine aggregates, that is, sand, stone screenings, or combinations thereof, are usually subjected in the laboratory to four routine tests; grading or mechanical color test for organic impurities. This is, of course, in addition to tests on the concourse, in addition to tests on the concrete fabricated from the aggregates being investigated. A discussion of the significance of these laboratory tests, as they apply to the use of sand for concrete road construction, will serve to call attention to some points which are not always appreciated by engineers. The grading of the concrete sand is an important consideration apart from any other test. If the sand is too fine, a weak mortar and a low resistance to wear will be produced.

If, on the other hand, it is too coarse, a harsh open mix difficult to work and with a consequent tendency towards the use of too much water will result. The average specification for sand controls the grading within safe limits. The trouble has been that many engineers look upon the test for mechanical analysis as secondary to the strength test, and are inclined to waive the former if the strength be within the specification requirement. A knowledge of the relations existing between the various tests would show that many sands much too coarse for satisfactory use in concrete will show very high strength ratios. Results of the strength test under these conditions are very misleading, because of the natural assumption that the higher the strength, the better the sand. The point to be emphasized here is that the strength test should only be considered in conjunction with the grading. If this is done, the strength of the sand for any given grading will be an indication of its quality. Thus, for a normally graded concrete sand, that is, one showing about 20 per cent coarser than a No. 20 sieve, a strength ratio of 100 per cent indicates satisfactory quality. A lower strength is an indication either of the presence of some deleterious substances such as organic matter, or that the sand grains are of poor quality. An unusually high strength invariably indicates a very coarsely graded sand. The color test for organic impurities alone is only an indication of danger, because there are substances found in concrete sands such as lignite, small particles of coal, etc., which show an unfavorable reaction and are still entirely harmless. If, however, the sand when normally graded shows low strength the chances are that the substances causing the color are of a harmful nature. If, on the other hand, the normally graded sample shows a low strength and no organic impurities, the trouble is undoubtedly due to poor quality of grains. Tests for silt content are usually positive indications, especially if the determination has been made by weight. Presence of silt in any sand which is to be used in a concrete surface exposed to wear is of course undesirable, for this fine material tends to work to the surface and greatly weaken it. The usual specification allows a limit of 3 per cent, and in concrete road construction it is seldom wise to exceed this limit. The term "silt" in this connection is used to cover only the material lost in the elutriation or washing test. It is usually composed of clay, loam or excessively fine sand, considerably finer than a No. 200 sieve. Ordinary fine sand passing a 100-mesh sieve is not harmful in amounts less than 10 per cent, providing the silt content is low.

Coarse Aggregates

Stone, gravel or slag which is to be used in the construction of concrete pavements should, in addition to being structurally sound, possess sufficient resistance to wear to withstand the abrasive action of traffic. This is particularly true in the case of city streets, which are subjected to an appreciable steel-tired traffic. The most commonly applied test for coarse aggregates is the Deval abrasion test. It was designed originally for use in testing macadam stone. The need for some form of test for quality of coarse aggregate led to its adoption for this purpose, in spite of the fact that there are many engineers who believe that it is wrong in principle when used in this connection. The test can be applied either to stone, slag or gravel. The methods of testing, however, are somewhat different, so that the results are not directly comparable. Opinion differs as to the proper test limits to apply when selecting aggregates for pavements. Many concrete roads constructed of stone with a percentage of wear as high as 6.5, or even 7.0, have given good service. As in the case of other materials, however, the best available aggregate should be used, and it is for the purpose of comparing available materials that this is of particular value. Although, as stated above, there is no direct relation between the results of abrasion tests of stone, gravel and slag, numerous laboratory tests have shown that, in general, these materials when of approximately equal quality will show results in the ratio of about 1:3-2. That is, gravel with a percentage of wear of 15 and slag with a percentage of wear of 10 will be of approximately the same quality as stone with a percentage of wear of 5. It will be observed that no reference is here made to the French coefficient of wear. Testing engineers are now practically unanimously in favor of abandoning this term. It really has no added significance, being merely the quotient obtained by dividing the constant 40 by the percentage of wear. It is rather difficult to discontinue the use of the term, however, because almost all highway engineers are accustomed to think only in terms of coefficients. With regard to tolerances, which should be allowed when interpreting this test, it is probable that, in general, the test is not accurate to less

than 0.5 per cent for stone or 1 per cent for slag or gravel, the difference being due to the fact that stone is usually more uniform than either of the other aggregates. Such a liberal tolerance is made necessary simply because the test cannot be depended upon to give results with any greater degree of accuracy. Many attempts have been made to improve the method, but so far none of them has been adopted as standard.

Although stone may be tested for hardness, toughness, etc., in addition to the abrasion test, the writer believes that the latter is sufficient control when the material is to be used for concrete aggregate. In the case of stone to be used in the construction of bituminious macadam or bituminous concrete roads, however, the toughness test has been found to be of value. In the case of gravel, uniformity of quality is the most essential requirement. This means freedom from soft, disintegrated fragments, and an impact test has been developed for determining the percentage of such fragments in a gravel sample. Sufficient data has not as yet been accumulated to permit setting any test limits. For slag, density is the chief requisite. To determine this a test for weight per cubic foot of crushed slag is made. The usual requirements specify a weight of 75 lbs. per cubic foot for pavements. Many good slag concrete roads have been built, however, with slag running as low as 70 lbs. to the foot. It would seem, however, that this is about as low as one should go until further information regarding the use of light slag in pavements is available. The Bureau of Public Roads has constructed and is now testing an experimental concrete pavement in which a large number of samples of stone, gravel and slag of widely varying characteristics are used. The results of this test should throw considerable light on this important question.

The proper grading or size of coarse aggregate will depend on the type of construction. Practice as regards concrete pavements varies in different parts of the country, a maximum size of 2¾ ins. being allowed in many of the Eastern states. The chances are that the maximum size is not an extremely important factor provided the aggregate is well graded from coarse to fine. A sample showing anywhere from 60 to 75 per cent retained on a screen intermediate in size between the largest and the smallest may be said to be satisfactorily graded. The maximum size of 2¾ ins., which is allowed in Pennsylvania, New Jersey, etc., is largely due to the added cost of further crushing the very hard and tough trap rock quarried in this section. Experience so far seems to indicate that the large stone is satisfactory.

In applying tolerances in connection with results of grading tests, it has been the custom in the past to allow a variation not to exceed 5 per cent larger than the maximum size or smaller than the minimum size, which is usually ¼-in. This is all right in theory, but does not work out very well in practice because, as is well known, stone, in general, retained on a ¼-in. revolving plant screen will often contain as much as 15 per cent passing a laboratory screen of the same size. Likewise, the efficient working of some gravel pits requires that the coarse aggregate carry considerable "tolerance" material. Purdue University recently conducted a series of tests to determine to what extent this so-called "tolerance" material was harmful, resulting in the conclusion that as high as 15 per cent might be allowed without seriously affecting the strength of the concrete. The principal consideration affecting control tests for grading of aggregates is that the material runs fairly uniform from day to day. This is usually determined by testing with a set of field screens right on the job or at the producing plant. One additional point in connection with screen analyses of aggregates should be mentioned. Some specifications call for the material to be the product of the crusher passing a revolving screen with openings of a certain size, say 3 ins. and to be retained on a revolving screen with openings of a certain size, say 1 in. Everyone who has had experience with crushing plant practice will realize how uncertain such a specification is. There are so many factors which influence the size of a stone product, such as the speed and angle of the screen, amount of moisture on the stone, etc., that the only safe plan is to specify that samples of the products be of definite size, as determined by laboratory screens. Knowing these requirements, the quarry man can adjust his equipment so that they can be complied with. It will be found that this is a much safer plan than to be compelled to accept aggregates simply because they were produced in a plant having screens of certain specified size.

Stone for Macadam

Turning now to stone to be used in macadam construction, we find not only

the abrasion test, but the toughness test and sometimes the hardness test used in examining the material. In a macadam road, the stone being held in place by a more or less non-rigid binder, is not supported on all sides to the same extent as the coarse aggregate in concrete. For this reason there is more chance for the individual fragments to wear in the macadam type, and consequently a greater necessity for a tough, durable stone, especially under heavy traffic. The engineer is justified, therefore, in taking only the best available stone, and the laboratory may often be of considerable assistance to him in making his selection. Good practice does not in general recommend the use of stone for bituminous macadam where the per cent of wear is more than 5.5. The toughness likewise should be at least 6.0. For mixed bituminous concrete a per cent of wear of not more than 5.0 and a toughness of at least 8 is usually required. The type of stone should also be taken into consideration. Many engineers specify a lower percentage of wear for trap or granite than for limestone for a given construction. This is done because the trap and granite are naturally much harder than the limestone, so that a trap showing a percentage of wear greater than normal is likely to be distintegrated or otherwise to be of inferior quality to the limestone, even though the actual wear as shown by the test is the same. Type is also an important consideration if water-bound or plain macadam construction is used. It is well known that certain types, such as the quartzite, gneiss, schists, etc., will not bond on the road, and for this reason they should not be used in the wearing course. Simple determination of type of road is all that is necessary in this case, which is partly the reason why the so-called "cementation test" for rock is not now used to any great extent.

Gravel for Surfacing

The testing of gravels for road surfacing is confined largely to a washing test to determine the percentage of clay present and a mechanical analysis to determine the grading of the sand and gravel from the maximum size down to dust, with the gravel fraction weighing about 2-3 of the total. Just enough clay should be present to act as a binder. The amount of clay to be allowed will depend on the character of the gravel, ranging from as little as possible in some limestone gravels to as high as 10 to 15 per cent by weight in pure quartz gravels. The maximum size will vary with condition but as a rule should not be placed at more than 2-3 the depth of the course when the gravel is to be used as a base and not more than 1½-inch for topping. The tendency recently has been for smaller gravel in the top. In order to control the quality of gravel for wearing course, an abrasion course is sometimes specified. Although when two or more available deposits are under consideration it is certainly advisable to take the one in which the best grade of stone occurs, it is not usually economically justifiable to reject local in favor of imported material simply on the score of an abrasion test. For this reason the writer would be inclined to waive this requirement under ordinary conditions provided the material was otherwise satisfactory. Due to the wide range in grading of the average gravel pit, it is essential that rather liberal tolerances be allowed if the road is to be built. For instance, it is hardly practical to reject pit run material which varies from 50 to 75 per cent retained on the ¼-in. screen. It is simply impossible in the case of most pits to secure material which will run any more uniform than this. Again, if a specification calls for a 10 per cent clay content, some tolerance, say 5 per cent, may be allowed. It is seldom wise to allow a clay content in any case in excess of 20 per cent.

Paving Brick

About the only test to which vitrified paving brick is now subjected is the standard rattler test. This test has been used a great many years and has given, in general, entire satisfaction, although the writer believes that it, in common with many other tests, can be improved. About the only point to which attention should be called here is the effect of size and type of brick on the rattler loss. It is known that repressed brick will lose slightly less than wire cut brick of equal quality due to rounded edges of the former. Likewise, 3-in. brick will show a somewhat greater percentage of wear than 4-in. brick of equal quality due to the greater number of linear inches of edges in proportion to weight which are exposed to wear. In the absence of specific data, one would probably be safe in allowing a 1-in. differential in favor of the wire cut type over the repressed and a 1 to 2 per cent differential for a 3-in. over a 4-in. brick.

Stone Block

Considerable trouble has in the past been experienced in the testing of stone

block chiefly because of the attempt to apply the macadam stone tests to this material. The writer has discussed this point a number of times and it will not be necessary to go into details in this paper. Suffice it to say that the Deval abrasion test is not accurate enough to differentiate between the various grades of granite block on the market except in a very rough way. In other words, in using this test, no attention should be paid to a few tenths of a per cent variation. The test will indicate the presence of soft, inferior stone and this is about as far as it can be depended upon.

Conclusion

In a paper of this length, it is, of course, impossible to go very much into the details of this important subject. It is hoped, however, that enough has been covered to indicate the major points to be considered. The object of the paper is to show the necessity of taking certain things into consideration when interpreting test data and when setting specification limits for materials. The fact that these things are not always considered is, the writer believes, the principal reason for much impractical interpretation of laboratory results. It is largely a question of mutual understanding, and the writer sincerely hopes that this paper will contribute at least slightly towards clearing up some of the doubtful points.

The foregoing paper by Mr. Jackson was presented before the recent annual convention of the American Society for Municipal Improvements.

PROTECTING HIGHWAY BRIDGES AGAINST FIRE

(Editor's note: The report of the Co-operative Committee on Fire Prevention in Highway Bridges is here presented in full. The committee personnel is as follows: Chairman, George W. Booth, Chief Engineer, National Board of Fire Underwriters; L. T. Ericson, Chief Engineer, The Jennison-Wright Company; C. M. Taylor, past President, American Wood Preserver's Association; D. F. Holtman, Construction Engineer, National Lumber Manufacturers' Association; C. J. Hogue, Manager, West Coast Forest Products Bureau; F. E. Schmitt, Associate Editor, Engineering News-Record; Secretary, E. F. Kelley, Senior Highway Bridge Engineer, United States Bureau of Public Roads.)

During the past few years a number of serious fires have occurred on important bridges and the circumstances attending these fires have indicated the desirability of making a detailed study of the situation in an attempt to bring out the important factors governing the fire hazard in timber bridge construction. With this purpose in mind a co-operative committee was formed representing fire protection, highway bridge construction, lumber, creosoting and the public interest, as given by the signatures hereto.

An extensive correspondence has been carried on with city, county and state bridge engineers, and with this and information collected from other available sources as a basis the committee submits the following report:

Fire Risk

The existence of a fire risk in bridges having wooden floors must be recognized. An indication of the importance of this risk is the fact that on some heavily traveled city bridges small fires are of daily occurrence during the summer months.

Mr. John D. Stevenson, Assistant Chief Engineer of the city of Pittsburgh, makes the following statement:

"The city has several steel bridges having wooden floors. Some of these are large structures crossing the rivers, and are important arteries of traffic. During the hot dry periods of the summer fires on these bridges are very frequent. They are of minor importance only, because we have been successful in extinguishing them before the flames have taken much of a hold. During the last summer on one bridge fires were a daily occurrence, and not infrequently two or three fires occurred in one day."

The annual report of the Fire Commissioners of the city of Holyoke, Mass., for the year 1921 states that during the year "the department responded to 170 fires on the various bridges. The month of June was particularly prominent in this respect, when the department responded to 64 alarms for bridge fires. This epidemic was lessened in the months to follow through the efforts of the Board of Public Works in sending the sprinkler over the county bridges frequently during the day. While the department has been very fortunate in the past in extinguishing bridge fires at a minimum loss, there is always danger of such a blaze getting so much headway as to cause the loss of one of the bridges."

In practically all cases the cause of these fires is stated in the report of the Fire Commissioners to be cigarette stubs.

The available evidence indicates that this risk is much less for country bridges than for city bridges, and is greater on long bridges than on short ones.

Causes of Fires

On city bridges fires are most commonly caused by the lodgment of lighted cigar or cigarette stubs in cracks or depressions where chaff and debris have collected. Decayed or splintered material in the floor adds greatly to the fire risk. In the case of country bridges the greatest risk is from forest and grass fires.

Other reported causes of fires are: Sparks from locomotives or steamboats, hot coals dropped by steam rollers, traction engines, tar kettles or other construction equipment; burning waste dropped by street cars; defective insulation of electric wiring; defective bonding of rails and lack of capacity in return feed wires of electric railways; fires in adjacent structures.

Relation of Preservative Treatment to Fire Risk

Creosoted material appears to be somewhat more difficult to ignite than untreated material, but once ignited it creates a fire which is hotter and more difficult to control, and which is known by experience to be more destructive than fire in an untreated floor. However, decayed or partially decayed untreated wood is very easily ignited and has been the cause of many fires. The likelihood of fire is increased by treatment which results in excessive bleeding of oil, such as might be caused by the heavy treatment of green lumber. It should be noted that freshly creosoted material is much more inflammable than that in which the treatment is several months old. It is urgently recommended that orders for creosoted material be placed as far as possible in advance of construction, and that the material be seasoned for from three to six months after treatment.

Where it is practicable to do so, freshly treated timber may be rendered more fire resistant by thoroughly coating the upper surface with sand. The application of sand should be continued as long as there is any bleeding of oil.

Construction

In general it may be stated that tightly laid floors, in which cracks are eliminated to a large extent, are most fire resistant.

Mr. Thomas J. Wasser, State Highway Engineer of New Jersey, states that prior to January, 1922, the old Raritan River bridge at Perth Amboy was decked with closely laid rough plank flooring, and that, to his knowledge, no fires were reported during the life of that floor. The deck was replanked with heavier lumber, surfaced on two sides and one edge, and laid with ½ inch openings. Since that time there have been seven small fires on the bridge, and it has been necessary for the department to put on a fire patrol to meet these conditions.

The relative fire risk of various types of floor may be stated as follows, beginning with the most fire resistive: Wood blocks on concrete base. This type of floor may be said to have no fire risk; wood blocks on plank sub-floor; laminated floor of 4 in., 6 in. or 8 in. strips laid on edge and spiked together, with a bituminous wearing surface; plank floor, with bituminous wearing surface; laminated floor without wearing surface; multiple thickness plank floor; single thickness plank floor.

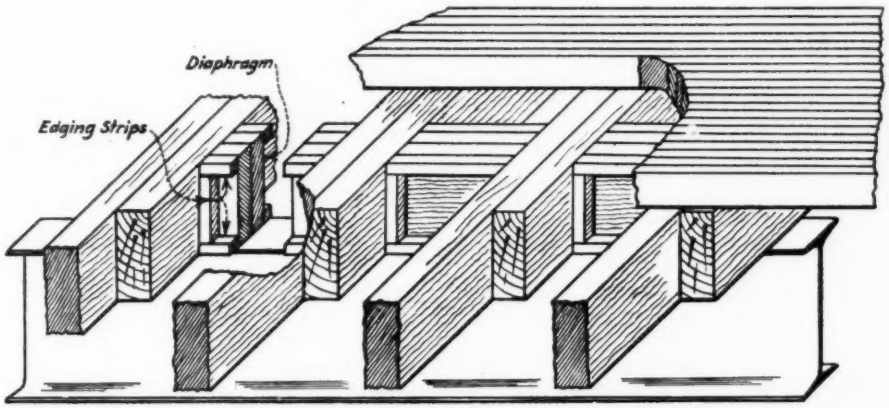
Steel joists or stringers supporting floors of any of the above types reduce the risk of rapid spread of fire by reducing the amount of combustible material exposed. Where wood joists or stringers are used the fire risk will be reduced by using heavy timbers for these members. The massing of combustible material renders it less susceptible to ignition and the spread of fire, and lessens the probability of serious structural damage before the fire can be controlled, in case fire-fighting means are at hand.

Special care should be exercised in the design of the floor and its supporting structure to avoid ledges or pockets in which trash may collect. The possibility of the accumulation of rubbish on truss members and in floor openings made for the passage of these members should be given careful consideration. In cases where such construction will not interfere with the proper disposal of floor drainage, curbs on timber floors should be constructed with ample clearance between curb and floor so that trash may have an opportunity to blow away.

To check the spread of fire lengthwise of the bridge the spaces between stringers, in cases where these rest on the floor beams, should be filled with tightly fitting diaphragms over each floor beam. Perhaps the most practicable method is

to use wooden diaphragms at least 6 ins. thick, which may be made up of two thicknesses of plank spiked together. Strips or battens should be placed around the edges of these diaphragms to cover cracks due to imperfect fitting or shrinkage. The accompanying sketch indicates the recommended construction.

In cases where limitation of headroom is not a factor, fire curtains of sheet metal extending at least 5 ft. below the bottoms of the joists and spaced at intervals of about 50 ft., will be of material assistance in preventing the spread of fire. The



SKETCH OF FIRE STOP DIAPHRAGMS OVER HIGHWAY BRIDGE FLOOR BEAMS.

corrugated asbestos-covered metal, as used for siding and roofing of buildings, is suggested for this purpose.

Maintenance

Floors, ledges and pockets and bridge seats should be kept free from street sweepings and other trash.

In the case of country bridges, particularly timber trestles, all underbrush, small timber, drift and debris, underneath and for some distance on both sides of the bridge should be removed. Grass and weeds should be cut in the early Fall and drift should be removed after floods. Where the vegetable growth is heavy, chemical weed killers are recommended as being economical and efficient.

Frequent inspections should be made of any conductors of electricity which may exist on the bridge.

Floors should be kept free from splintered and decayed wood.

Provisions for Fire Fighting

For bridges where watchmen or bridge tenders are employed, water barrels, sand boxes or water mains may be employed to advantage for fighting fires. For bridges not under constant supervision the value of any of the above is questionable, although sand boxes would probably be most likely to be ready for use when needed.

Water barrels and sand boxes should be covered and the surface of the water in the barrels should be covered with a light film of oil.

In cold climates freezing of the water in barrels can be prevented by the addition of a suitable amount of calcium chloride.

When water mains are provided they should have hose connections every 50 ft. and hose reels every 200 ft. In cold climates they must either be protected against freezing or be kept empty with provisions for supplying them with water under pressure, either from hydrants direct or from fire engines.

Watchmen and drawbridge tenders should be provided with at least one 2½ gal. soda-acid fire extinguisher. Where aid may be expected from a municipal fire department, there should be provided some means of transmitting alarms. If watchmen or bridge tenders are on duty, a telephone may be considered as a substitute for the more reliable and satisfactory public box on a fire alarm telegraph system.

Maintenance of the under-structure and the use of fire fighting appliances will be facilitated by providing under the bridge floor, on each side of each pier and at intermediate points not more than 100 ft. apart, platforms constructed of fire resistive material. Access to these platforms may be secured either by hatchways in the bridge deck or by stairs on the outside of the bridge.

In cases where fire streams from hose

and nozzles are available, there should also be provided at 20-ft. intervals, both longitudinally and transversely, openings in the bridge deck to permit the use of cellar pipes, revolving nozzles or similar devices. These openings should be not less than 10 ins. in diameter, and should be provided with metal covers, which can be easily removed but not readily displaced by accident.

Fire Retardant Paints or Treatment

The weight of the evidence, obtained from laboratories which have investigated this subject, is to the effect that, whatever may be expected from future experimentation, there is at present little that can be accomplished in the way of rendering wood fire resistive by means of a paint coating or other treatment by chemical methods. A paint coating which is not readily combustible may, however, serve to delay slightly the time in which the lumber reaches its maximum susceptibility to ignition. The difficulty with the chemical treatment is that the chemicals will either wash out or, if waterproof, are not fire resistive.

Conclusion

The investigation having shown that the subject of bridge fire protection is of an importance not previously recognized, the committee desires to emphasize the need for giving consideration to the fire risk in the design of highway bridges. Public officials having bridges in their charge have a clear responsibility in the matter, and the committee desires to call to the attention of such authorities the desirability of protecting bridges by due care in design and construction, by watchful maintenance, and by provision for preventing and fighting fires.

FARMERS GET FIRE PROTECTION THROUGH GOOD ROADS

Dallas County, Texas, has made it possible for its rural districts to obtain protection from the fire department in Dallas through the construction of modern hard-surfaced highways. A contract executed recently between the Dallas City Commission and the County Commisioners provides for fire protection to farmers on all paved roads within a radius of fifteen miles of Dallas. When a farm house or barn along a paved road catches fire all the farmer has to do is to telephone the Dallas department and it will respond at forty to fifty miles an hour with a chemical engine or a steamer, as occasion may warrant.

Dallas county is one of the first in the country to make such an arrangement. Several fires have already been extinguished with small loss. A general reduction in fire insurance rates in the smaller towns and farming districts has been the result. The service will be made more extensive when the big road building program now under way in Dallas county is finished. Farmers affected by the arrangement are reported to be delighted with the protection afforded.

CONSTRUCTION OF MILWAUKEE ACTIVATED SLUDGE SEWAGE DISPOSAL PLANT

By R. R. Lundahl, Assistant Engineer, Milwaukee Sewerage Commission, City Hall, Milwaukee, Wis.

General Arrangement of Plant and Design Features

Conditions foreseen in the operation of a large activated sludge sewage disposal plant, suggested an arrangement similar to that of a large mechanical water filtration plant. Referring to Fig. 1, showing the plant layout, it will be seen to consist of 24 aeration and 15 settling tanks; one row of aeration and one row of settling tanks on either side of the east and west center line of the plant.

The sewage, after having passed through the grit chambers and fine screens, and after having received the proper amount of activated sludge at the outlet end of the fine screens, will pass through the mixing channel between the fine screens and the plant and will enter the main channel at the extreme western end of the plant. At this point, the flow will divide, a portion going north and east to feed the north aeration tanks and a portion going south and east to feed the south aeration tanks. Eech tank is separated into two compartments by a baffle wall. The sewage enters the west compartments through feed pipes, and leaves through overflow weirs and meters placed in the ends of the east compartments. The outlet pipes pass through the two feed channels and discharge into the mixed liquor channels surrounding each settling tank on three sides.

The settling tanks take their supply from the mixed liquor channels through submerged gates, the effluent being collected in troughs which discharge into the effluent channels. The "settlings" or

TABLE I.

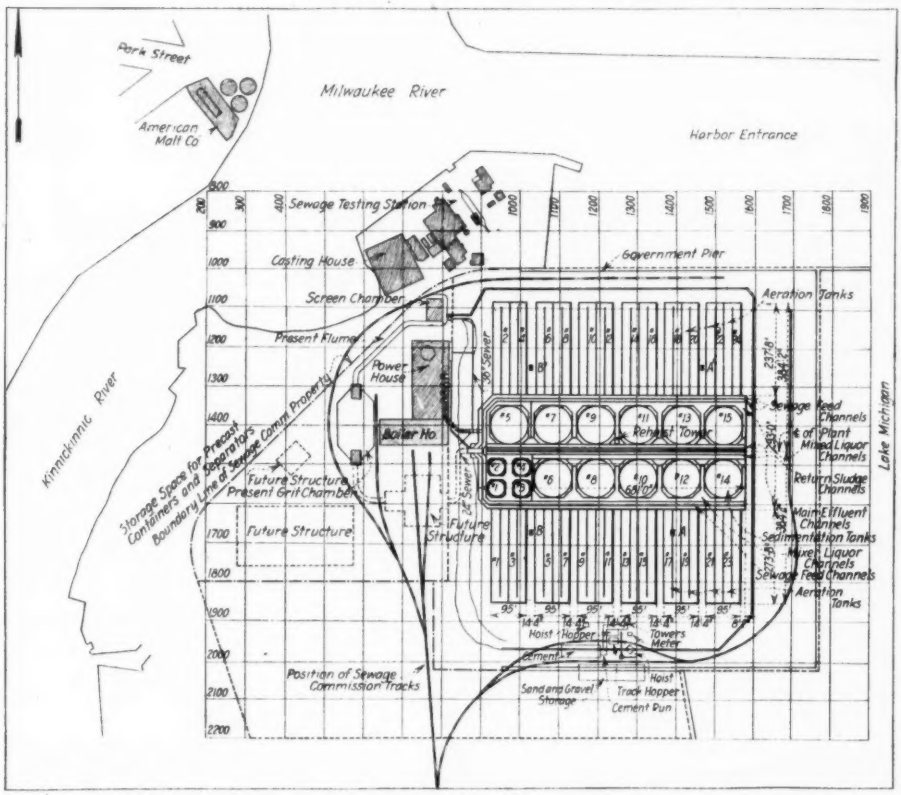
	Average	Aver. With Storm Water	Maximum	Max. With Storm Water
1914	50,283,000	51,583,000	75.400,000	113,210,000
1930	85,183,000	86,483,000	127,800,000	165,610,000
1950	128,775,000	130,075,000	193,200,000	231,010,000

sludge is withdrawn from the bottoms of the tanks and conveyed to the return sludge pumps located in the northeast corner of the main power house. From these pumps it is forced to the point of feed at the fine screen outlet previously mentioned.

The plant being constructed at the present time is calculated to provide treatment facilities for an estimated 1930 population of 588,750 inhabitants. Table 1 shows the estimated average and maximum rates of sewage flow per day for the disposal plant design:

The plant is based on the treatment of 15 million gallons per acre per day, for the net area of the sewage surface in the aeration tanks. The tanks have an effective depth of 15 ft. and with a 20 per cent by volume of activated sludge in the mixture, the detention period will be approximately six hours. The tanks are of such a size that they will treat an average of 3,580,500 gallons each per day. The size of the settling tanks are based on the figure of 1,600 gallons per square foot per day, determined from our experiments. This figure pertains to the number of gallons of sewage which can be settled every 24 hours on each square foot of horizontal liquid surface and does not include 20 per cent mixture of sludge in the sewage. The tanks are 98 feet in diameter at the bottom and octagonal at the top, the sides and corners being on a 2 to 1 slope so that there can be no deposits on the sides of the tanks.

The bottoms of all of the channels excluding the effluent channels will contain air diffuser plates as well as the entire bottoms of the aeration tanks. Only the area of the plates in the tanks was con-



GENERAL PLAN OF MILWAUKEE ACTIVATED SLUDGE SEWAGE DISPOSAL PLANT.

sidered in the design so we will have the added factor of safety of all the aeration that takes place in the several channels.

The quantity of sludge to be withdrawn from the settling tanks is to be controlled by the difference in head between the elevation of the sewage surface in the tanks and the elevation of the ends of the adjustable draw off pipes. It is estimated that the plant will produce sludge at the rate of 15,000 gals. (98.5% moisture) per million gallons of sewage treated, the total quantity for 1930 being approximately 1,275,000 gals. per day.

All excess sludge created will be pressed by Oliver Filter Presses and then dried down to a 10 per cent moisture content. The type of drier to be used has not as yet been selected but practically any type of commercial drier can handle the material after it has been dewatered in the presses to an 80 per cent moisture content. The dried sludge will be sold as fertilizer base, as it contains from 5 per cent to 7 per cent available nitrogen.

Construction of Plant

Actual work on the construction of the sewage plant was started in 1918. At this time the main valve chamber, coarse screen house, pump well and grit chambers, were constructed. In 1920 about 10 acres of Lake Michigan were reclaimed, forming land for the location of the aeration and sedimentation units of the plant. In 1921 the foundation piles were driven for the aeration and sedimentation tanks (22,500 wood piles) and the foundations of the power house and boiler house were built.

In April, 1922, the contract for building the aeration and sedimentation units of the plant was awarded to the Du Pont Engineering Co. of Wilmington, Delaware; the steel superstructures for the power and boiler house were completed in August, 1921, and work on the masonry started immediately and is now nearing completion.

Activities were started by the Du Pont Co. early in May, 1922, setting up their plant and equipment. In Fig. 1 a railroad track surrounding the entire area is shown; this track, the property of the Sewerage Commission, was turned over to the Du Pont Co. to use as they saw fit, and accordingly it was incorporated in the scheme of the plant layout. The plant was planned so as to use the Insley tower and spouting system for placing all the concrete.

By referring to Fig. 1 the plan of the plant layout is shown. Track hopper, storage hopper, cement storage, mixers and two main hoisting towers, electric

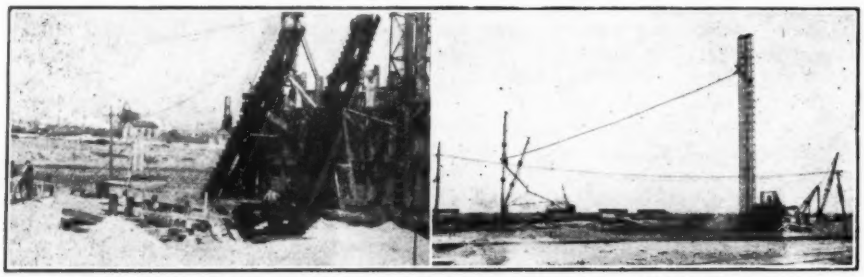


FIG. 2—VIEW OF TRACK HOPPER MATERIAL BINS AND CONVEYORS. FIG. 3—GENERAL VIEW OF PLANT ON MAY 22, 1922.

hoist for the main towers and the stiff leg derrick used in handling the sand from storage and from cars, are shown. The storage piles for sand and gravel are so indicated. Fig. 2 is a view of the storage hopper with elevating conveyors and the foundation for the track hopper in the foreground. This plant was intended to place all the concrete for the south half of the plant. Fig. 3 shows the plant ready for operation. The high line from the main towers to the mast derrick, supports the line of spouts and the derrick carries a conical hopper and counterbalance chutes covering a radius of approximately 200 ft. The mast derrick was first set up at "A" Fig. 1, and later at "B." The main towers are 216 ft. high and the derrick is located approximately 300 ft. from the towers.

The plant is operated as follows: The gravel is dumped from cars into the track hopper and thence elevated to the storage hopper; the sand is clammed from cars or storage, into the track hopper and then elevated. There are four compartments in the storage hopper, one sand

and one gravel for each of the two "T. L. Smith" mixers of 1 1-3 yd capacity. The sand and gravel are drawn from the storage hopper into a measuring bin or hopper directly over each mixer; the cement is brought from the storage shed in bottom dump cars of 9-sack capacity (the cement is received in cloth sacks) operated on a continuous trolley. The cement and sand fill one bin flush and the gravel the other and all is discharged into the mixer simultaneously. The water is automatically controlled at a constant amount and one operator controls both mixers, from the feeding platform.

There is a separate tower for each mixer but the dump hopper of one is connected to the other so that both feed the same line of spouts. The hopper arrangement is plainly shown in Fig. 3, one operator controlling the dumping at the top. One engineer operates both hoists. The round trip of each bucket averages 2 minutes.

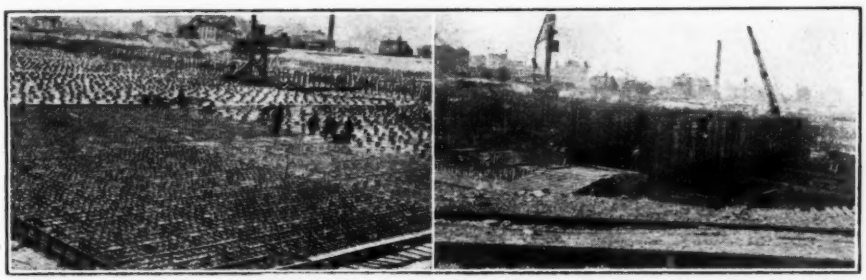


FIG. 4—VIEW OF BOTTOM SLAB STEEL SET IN SOUTH END OF AERATION TANKS 21-23 AND A PORTION OF SIDE FORMS IN PLACE. FIG. 5—VIEW OF ERECTION OF STEEL FORMS FOR AERATION WALLS.

The stel reinforcing is furnished by the Sewerage Commission on board cars, but is unloaded and placed by the contractor. The rods are all cut to length and all bends made before the steel is received. A locomotive crane is employed to unload the reinforcing, but after that time it is handled entirely by hand. Fig. 4 is a view of the steel in place for the bottom slab of an aeration tank. Note how perfectly the rods are all placed. There are two mats of steel top and bottom, of 1-in. round rods, supported by spikes driven into the wood piles and by chairs set on top of the piles. Considerable difficulty was experienced at first in supporting the steel mats but this has now all been overcome.

Forms

The original plan was to use steel forms for the entire structure and elaborate changes in the plans were made so that they could be used. Plans were made and the forms all constructed and tried out with the result that wood panel forms have been substituted in nearly every case. The steel forms proved to be very cumbersome and entirely unsuited for the purpose. The only place where the steel forms are being used at present is for the walls of the aeration tanks, and the small drains. Fig. 5 shows the steel forms used for the aeration tank walls as they were being set for the first time. Note the caterpillar crane between the walls used at first in setting the forms. At present the forms are handled by means of two gantry frames; one removes the forms and carries them to the end of the tank, from whence they are picked up by the locomotive crane and carried to the next gantry frame which then picks up and sets the form. On an average, 220 ft. or 11 sections of form are removed and again set, in an 8-hour day.

Fig. 6 shows a completed aeration tank bottom slab with all the wall dowels in place. Fig. 7 shows the same slab, after the vertical wall steel has been wired in place preparatory to setting the wall forms.

Expansion Joints

The entire sewage plant is uniquely divided to take care of expansion and contraction. Three joints extend the entire length of the plant from east to west; one directly on the center line of the plant; one on the south side of the plant at the north edge of the northerly feed channel slab, separating the south aeration units from the south sedimentation units, and the other in a corresponding location on the north side of the plant. There are five joints running north and south, each located on the center line between the adjoining sedimentation tanks. These joints extend through the

concrete from the bottom slab to the top, including all the walls, intermediate slabs, walkways, etc., so that there is a complete division of the structure at each of the joints.

This arrangement of the joints allows each separate settling tank, and each battery of aeration tanks, together with the adjoining channels, to function as a separate and distinct structure as regards expansion and contraction.

The joints are 1½-in. in thickness, being made up of three thicknesses of Carey Elastite Expansion Joint, each ½-in. thick. This Elastite is bolted to a crimped section of 20-gauge copper (in this case furnished by the Atlas Copper Co. of Chicago), being lapped and fitted

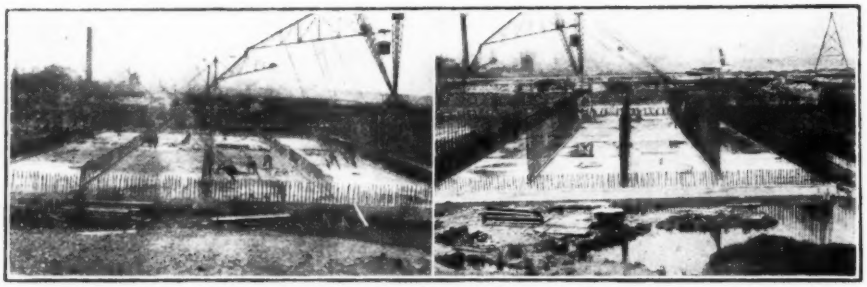


FIG. 6—AERATION TANK 13-15 SHOWING BOTTOM SLAB WITH WALL DOWELS ALL SET TO RECEIVE WALL REINFORCING. AERATION TANK 17-19 SHOWING BOTTOM SLAB WITH WALL STEEL IN POSITION.

so as to make the strongest section. The sections are made up male and female ends so that the copper laps 3 inches when the joint is in position, and the outstanding wings of the copper are then riveted together in the straight sections, and soldered in the special sections. This oustanding wing of copper is anchored into the concrete of the adjoining sections on either side of the expansion joint so that the joint is absolutely watertight.

Special tees, ells and crosses were designed, for use wherever intersections of walls and slabs occurred, so that the expansion joint and also the water seal at each joint would be absolutely continuous. It required considerable ingenuity so to design and construct these specials, so that the expansion could take place in any direction and the joint still remain watertight. The several sections of joints were all made up and bolted together before being carried down to the work.

Discussion of Plant

The plant as designed was calculated to be able to place a maximum of 800 yds. of concrete in 8 hrs., averaging 600 yds. per 8-hour day. The best the equipment has ever done was to place 75 yds. in an hour and 480 yds. in a day's run, considerably over 8 hrs. The material storage is inadequate, no method of handling from storage is provided and the entire plant hinges on the receiving of materials in dump bottom cars, which has at times materially delayed progress and entailed considerable expense in car demurrage. The entire plant is wholly unsuited for the work to be done, lacking in flexibility, capacity and ease of doing the work. The lack of flexibility has been the most serious drawback.

The layout of the work lends itself most admirably to the use of the cableway system, and experience has shown the fallacy of using the spouting method of concreting in this particular plant. Not alone is there concrete to place, and forms to handle, but there is considerable structural steel to be set, pieces weighing upwards of 12 tons, motors to place, thickeners and their mechanisms, sluice gates, gate valves, sludge draw off pipes, large cast iron air mains, diffuser plate containers and separator blocks, brick and stone for the superstructures, the handling of all of which could best be done by means of a cable way. The first cost of a cable way plant for doing all of the work, consisting of two cable ways, was quoted at about $160,000, materially more in first cost than the spouting system, but the difference would have been more than offset in the economy of doing the work.

Summary

There is approximately 65,000 cu. yds. of concrete in the plant, of which about 30,000 yds. wil be in place this season; 5,000 tons of reinforcing steel, of which 60 per cent will be in place, and nearly all of the cast iron pipe for sludge draw will be

in position. Next season will require the completion of all of the concrete work, setting of all gates, valves, pipes, steel work, containers, etc., and the completion of the superstructures. There will be no work carried on during the winter months,

Mr. P. Millard is the general manager in charge of the work for the Du Pont Co. and Mr. McLean the field superintendent. The work is all done under the direction of the Sewerage Commission Engineers, of which T. Chalkley Hatton is chief. George W. Rauch is the division engineer in direct charge of the field work.

PUTTING MUNICIPALLY OWNED WATER PLANTS ON A BUSINESS BASIS

By V. Bernard Siems, Associate Civil Engineer, Water Department, Baltimore, Md.

As a general rule the Water Departments in most cities show a deficit at the end of each year. The primary causes for such losses are: Insufficient rates—water being sold below cost; free water, i. e., water distributed to other municipal departments, such as public schools, hospitals, and other institutions, and for the cleaning of streets and kindred uses, in practically unlimited quantities and without receiving any revenue therefor; and unrestricted water waste, both on the distribution system and from the defective plumbing fixtures of private individuals.

Fair Rates

The determination of a water rate which is fair both to the operators of the water works and to the consumer demands a consideration of many factors. These are briefly suggested: Necessary operating expenses; ample allowance for the maintenance of the system; depreciation charges; interest charges on investment; quantity of free water supplied; and the quantity of water wasted by the consumers. Bearing these outstanding points in mind the consideration of a system of charges may be begun. The basis of any system of charges for service rendered by a public utility should be in conformity with the principles of equity, that is, the charges should be exactly proportionate to the amount of service rendered, and the amount of water service received can only be measured by having a water meter on each water supply service. It is, therefore, advisable that the system be 100% metered.

Front footage water service rates are unjust in that there is absolutely no relationship between the width of the dwelling and the amount of water consumed, and besides an unmetered supply permits of much waste. A rate based upon the number of water fixtures in a building is also an unjust system, as there is no relation between the number of fixtures and the number of occupants. The consumption is dependent, however, upon the number of occupants or the character of business carried on at the property supplied.

State Regulation Advocated

The regulation of privately-owned utilities is now an accomplished fact, and it has unquestionably worked both to the advantage of the utility and the consumer. There can be no sound objection to state regulation of municipally-owned utilities, for if these enterprises are properly and successfully conducted, then everyone interested therein should welcome the opportunity to give the widest publicity to their activities. The hearings and reports of the various Public Service Commissions afford such publicity and embody the experience of men trained to analyze utility operations. It should be a source of gratification to all citizens to know that such a body of experts under the guidance of responsible commissioners are available to consider complaints and to supervise the finances of the municipal enterprise.

The Supreme Court of the United States has ruled in a number of instances that Public Service Commissions have no jurisdiction over the rates of municipally-owned utilities, but it is believed, however, that by special legislative enactment such powers can be granted. This principle is recognized by the state of Wisconsin, and referring to the "Public Service Magazine," issue of January, 1922, we find that the tax commissioners of the state of Wisconsin are to levy an impost on the municipality of Stoughton, which had made itself amenable to state taxation by extending its electric service outside the city limits. Stoughton has applied to the Public Service Commission for permission to increase its rates to meet the tax.

Tax Exemption Misleads

Municipal plants do not pay taxes and therefore their rightful share of taxation is absorbed by the public, and not being subjected to such rigid regulations and supervision as are the privately-owned utilities, taxpayers are sometimes misled

regarding the actual financial situation as any deficit is supplied by additions to the tax rate.

A specific instance will best illustrate the characteristics of a self-supporting, municipally operated public utility and the salient features of the plan advocated are therefore briefly illustrated by applying the suggested measures to the operation of the Baltimore City Water Department.

Baltimore as an Example

The investment in plant and property of the Water Department of Greater Baltimore is estimated to be $35,000,000. By applying a 5% rate of return to this capital investment, the net return would be $1,750,000. It is the general practice, however, of the Public Service Commissions of the country to allow a rate of return of at least 7 per cent to public service corporations. As it is the purpose of a municipally-owned utility to furnish service to the public at cost, the net return of $1,750,000, which is in addition to operating and maintenance costs, wil cover the annual sinking fund and interest on the present water loans, and will create a reserve amount to finance future additions or enlargements to the water system.

The estimated sinking funds and interest payments are considered to be constant for the duration of the loan. The accumulative reserve amount, in the intervals between its use by the Water Department for financing extensions, could be used by the City Comptroller for temporary financing, and would obviate any short time borrowing by the city. In order that the necessary increase of this sum would not be interrupted, however, it would be necessary that the market rate of interest be paid on such loans.

The annual depreciation covers the cost of renewing the parts of the impounding, purification, pumpage and distribution works which have deteriorated or have been damaged by use; $350,000, or 1 per cent of the value of the plant being so charged.

By adding together the fair net return of $1,750,000, or 5 per cent on the approximate investment in the present plant and the private water companies, and an annual depreciation of $350,000, or 1 per cent on the assumed valuation, together with the operating expenses, aggregating $1,715,000, of the present department and private water companies, $3,815,000 is obtained as the total service revenue required to make the enlarged Water Department self-sustaining. Having determined the total service revenue required, the necessary allocation can be made so that the charges will be equitably distributed and in direct proportion to the cost of delivering water to the respective consumers.

The total service revenue may be divided into that received from public fire protection and that derived from general water service. The amount to be charged to public fire protection is determined by multiplying the total number of fire hydrants in the city by a unit charge of $40, the result—$192,000—being 5 per cent of the total service revenue. The amount of water that must be potentially available for fire protection increases enormously the capital expenditure on a water distribution system. The general tax levy is the proper source from which the entire cost of public fire protection should be received, as it is then paid in proportion to the value of the property protected.

By deducting the public fire protection revenue from the total revenue the general water service revenue, aggregating $3,623,000, is obtained. This sum, which includes the revenue to be received from private fire protection services, is the amount received from the water consumer. In order that the water service rates may be in direct proportion to the cost of furnishing water to each consumer, the general water service revenue is subdivided into the amount to be received from the fixed service charge and that to be received from the consumption charge. By taking 40 per cent of the general water service revenue, the fixed service charge of $1,449,200 is obtained.

The fixed charge covers the cost of service, and does not vary as the amount of water consumed, but is a constant charge comprising two elements of cost: namely, the capacity or readiness to serve cost, and the consumer's cost. The capacity or readiness to serve cost is the cost of labor, material and interest appurtenant to that part of the plant which is idle when the normal demand exists, but which is held in readiness to supply the maximum demand. The Consumer's charge covers the cost of reading meters, etc., and varies but little. This charge of $362,300 is obtained by deducting the readiness to serve cost from the fixed service cost. The sum of $2,173,800 to be received from the consumption charge, is obtained by deducting the fixed service

revenue from the general water service revenue.

Having obtained the proper allocation of the revenue, the water service rates, consisting of a fixed service charge and a consumption charge, can be determined. As previously stated, the fixed service charge comprises the capacity or readiness to serve charge and the consumer's charge. In order that the capacity charge may be proportional to the maximum capacity of the different sized meters, ratios were ascertained by taking the flow of a ⅝-inch meter as unity and determining the ratios of larger meters thereby. By dividing the capacity or readiness to serve charge revenue by the total number of units, the yearly unit capacity charge of $4.30 per meter is obtained. The consumer's charge revenue divided by the total number of services gives a yearly consumer's charge of $2.35 per meter. The yearly fixed service charge, that is, the yearly unit capacity charge of $4.30 and the yearly consumer's charge of $2.35 therefore varies from $6.65 for a ⅝-in. meter to over $1,400 for a 12-in. meter. This fixed service rate is chargeable whether the consumer has used water or not, as the water plant must be held in readiness at all times to deliver his maximum demand.

The next step in devising the schedule of rates is to determine the rate per unit of water to be assessed in addition to the fixed service charge. By deducting the fixed service charge revenue from the general water service revenue, the water service revenue of $2,173,190.75 is obtained, and considering a revenue bearing water consumption of over three billion cubic feet per year the average water service rate would be 70 cents per 1,000 cu. feet. At the cost per unit decreases as the demand increases, a sliding scale of rates has been devised, allowing four classes of consumption and varying from 80 cents per 1,000 cu. feet, for small consumers, to 28 cents for those using five million cu. feet per year. Domestic services are to be charged a minimum fixed meter service rate of $12.50, allowing a yearly consumption of 7,300 cu. feet based upon the use of 30 gallons per capita per day for an average family, any excess thereover to be charged for at the sliding scale rate. The majority of the smaller residential properties will come under this class.

The preceding schedule of water rates is just, reasonable, and not discriminatory; and devised to meet conditions which must be provided for in any efficiently managed utility. It cannot be argued that rates are excessive which provide revenue only sufficient to take care of operating and maintenance expenses, sinking funds, interest on the various bond issues, and a small surplus to be used for any necessary extensions. Of the amount designated as a fair net return any excess over interest charges is to be applied to the retiring of the existing bond issues, and to the creation of a surplus for the financing of any future additions or improvements.

While the subject of bond issues is touched upon, it may be said that it is unwise to extend the term of bonds over a greater number of years than the effective life of the work which they are to finance, as the direct benefit of the improvements is secured by the present generation, although the usual loans extend over such a long period of time that the following generation is still taxed without receiving any proportionate benefit. This opinion is also expressed by that portion of the Constitution of Maryland which reads that "no debt shall be hereafter contracted by the General Assembly unless such debt shall be authorized by a law providing for the collection of an annual tax or taxes sufficient to pay the interest on such debt as it falls due, and also to discharge the principal thereof within 15 years from the time of contracting same * * *"

The foregoing discussion has dealt exclusively with the financial operation of a water department. The essential difference between such a department and other municipal operations must next be considered and such distinctions judged from the viewpoint of the advisability of their operations as self-supporting financial units.

Still continuing to apply our reasoning with the city of Baltimore as an example the various municipal activities apart from the sale of water must be considered. Second in importance to a supply of potable water is an efficient system for the disposal of waste, that is, the Sewer Division. Any charge levied on the individual consumer to make this department self-supporting would partake in general of the characteristics of a flat rate. If a flat rate is to be levied, a far more convenient method of payment would be by including this charge in the tax rate proper, which is, in fact, the present method of supporting the sewerage system. As there is, however, a direct and

unvarying relation between the amount of water consumed on each premise and the amount of waste water issuing therefrom, a revenue bearing system for sewerage service could be constructed, based upon the metered consumption of the property. This carries us back to one of the first statements made in this paper—it is absolutely essential that a city be 100 per cent metered.

The disposal of garbage and ashes is another municipal function. As it would not be feasible to weigh or otherwise make a definite unit charge for each cu. foot of matter removed, a flat rate charge would again have to be assessed, and the general tax levy is the proper place for such charges to be made. The Street Cleaning Department—responsible for the cleanliness of all thoroughfares—is another city unit which serves every citizen, but the individual property owner cannot be expected to pay for the benefit derived according to the front footage of his property. The expenses of this department should, therefore, be taken from the general tax levy. The maintenance of the municipal hospital and almshouses indirectly benefits each and every citizen, but as the patient is rendered free attention the charge must be distributed over the entire population, that is, taken from the tax rate. The various activities of the Health Department also fall within this category. By this elimination of all other municipal activities the Water Department stands forth alone as an organization capable of being made into an efficient self-supporting organization, selling service at cost to all citizens who are, moreover, not merely consumers and therefore revenue producers, but as citizens of the municipality, also owners of the plant itself.

One of the foremost authorities on water works known for the keenness of his reasoning—I refer to Mr. Nicholas S. Hill, Jr., of New York City—has given much consideration to the efficient management of municipally-owned water works and as chairman of a committee, delivered a report on water works and water supply at the 1921 convention of the American Society for Municipal Improvements. Mr. Hill gave a resume of the characteristic features of a great majority of municipally-owned water works and then gave a frank discussion of the essential weaknesses of these organizations and the imperative need of radical changes. Such topics as personnel—the questionable practice of employing mediocre engineers on insufficient salaries; the absolute absence of justly apportioned water rates; the practice of meeting deficits by appropriations taken from the tax levy and the need of an adequate accounting system and a uniform scheme of reports were all touched upon in some detail. Such subjects as the standardization of materials and equipment, the efficiency of various types of machinery, the need of adequate rainfall and run-off records, the design of works for the collection and distribution of water, standards for water quality, the need of water softening and water purification, and the relation of the water supply and various diseases were also discussed.

What I especially wished to bring to your attention, however, is the following quotation from his paper:

"There is no aspect of the problem of water works management and maintenance which has been given so little attention on the part of municipal officials as the economic aspect of the problem, and there is a great opportunity in this country for placing municipally-owned water works on a sound financial basis by the establishment of rate structures which will not only provide the money necessary for their maintenance and operation but which will not unjustly and unfairly discriminate betwen different classes of consumers."

The above paragraph states an idea worthy of the deepest consideration.

The preceding paper, recently presented before the Four States Section of the American Water Works Association, was suggested by some of the ideas embodied in reports entitled, "Investigation of the Water Supply Improvements for Greater Baltimore" and "Recommended Schedule of Rates for the Water Department of the City of Baltimore," which were submitted by the writer to the Water Engineer.

FOOTPATHS PROPOSED FOR NEW JERSEY ROADS

Good roads enthusiasts will present to the next session of the New Jersey legislature a bill providing for the construction of footpaths along the state highways. New Jersey has hundreds of miles of beautful tree-lined asphalt roads and the State Highway Commission is favorable to the footpath idea, believing that the paths will keep pedestrians off the roadway and thereby greatly reduce highway

accidents. An attempt will be made with the support of the State Highway Commision to amend the state highway act with the following provision: "Proper footpaths for the use of pedestrians may be constructed on such portions of any state highway where, in the opinion of the State Highway Commision, such construction is necessary or advisable."

COST OF BUILDING FLOW PARTITION WALLS IN IMHOFF TANKS BY CEMENT GUN METHOD

By George B. Gascoigne, Consulting Engineer, Leader-News Bldg., Cleveland, O.

One of the items in the construction of the Westerly Sewage Treatment Works, city of Cleveland, called for the building of 9,500 sq. yds. of flow partition walls in the two-story settling tanks. These partitions separate the flow compartments and gas vents, and as usually built require much form work and difficulty in placing concrete due to the thin sections involved. As this is the first instance, to the writer's knowledge, of the use of the cement gun in building flow partitions 3 ins. thick, the methods used and cost data should be of interest.

Description of Work

The Westerly Sewage Treatment Works included, as part of the scheme of treatment, 16 settling tanks. Fig. No. 1 shows a cross section of one of these units, and Fig. 2 a longitudinal section. As will be seen, the tanks which are 50 ft. long, are each divided into four flow compartments by means of 8 partition walls. The area of partitions is 580 sq. yds. per tank, or 9,280 sq. yds. total, to which an addition must be made for wastage in ends and corners. The upper portions of the partition walls, to a point 2 ft. below the flow line, were built of formed reinforced concrete, but below this point gunite was used. The net thickness of the gunite partition was 3 ins., built up of four coats of cement mortar on metal lath. The span center to center of supporting cross walls was 9 ft. As horizontal reinforcement No. 24 gauge" Self-Sentering" metal lath was used, which gave a computed load-carrying capacity of 100 lbs. per sq. ft., amply sufficient in view of the facts that this partition carries practically no load, and that the water pressures on the two sides always balance each other.

Details of Construction

Fig. 3 shows the details of construction. The metal lath was placed with the ribs running horizontally and attached to ⅜-in. dowels set in the cross walls 12 ins. apart, the projecting ends of which were bent down over a ½-in. rod to hold the lath in place. To increase the stiffness and continuity a system of No. 4 gauge wires placed diagonally 18 ins. on center

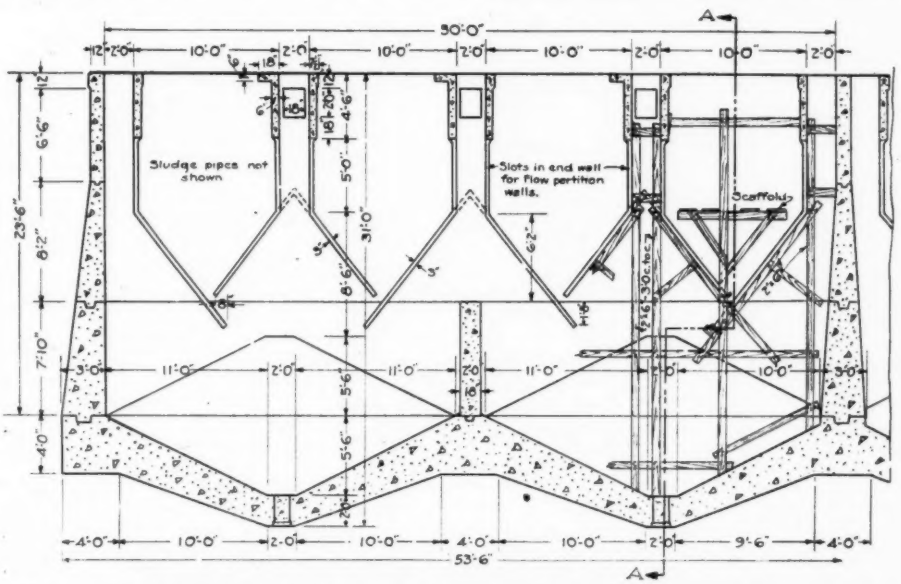


FIG. 1—TRANSVERSE SECTION THROUGH ONE IMHOFF SETTLING TANK, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

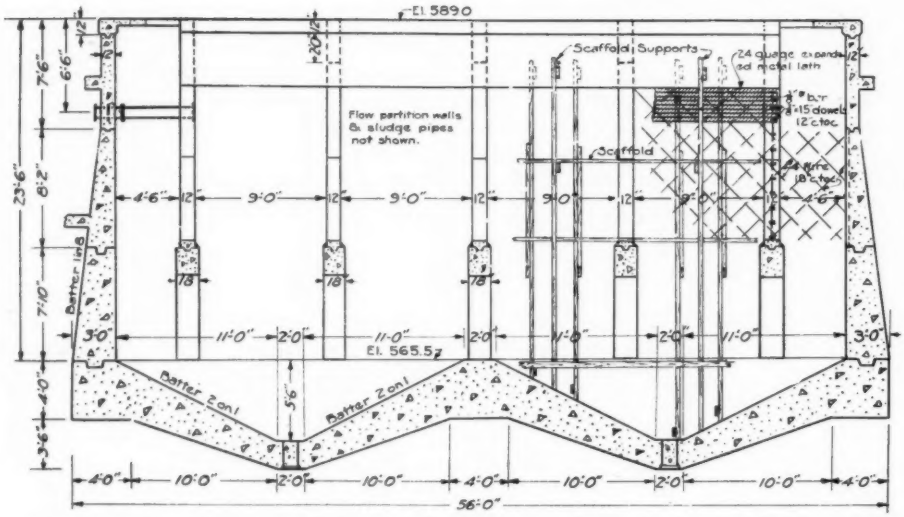


FIG. 2—LONGITUDINAL SECTION THROUGH ONE IMHOFF SETTLING TANK, WESTERLY SEWAGE TREAMENT WORKS, CLEVELAND, OHIO.

in both directions was fastened to the back of the metal lath. Adjoining sections of lath were lapped 10 ins. on ends, and the ribs interlocked lengthwise and all intersections were well wired.

This made a very stiff structure, and the only additional support needed to hold the green walls in place while setting or being concreted consisted of bents of 2 by 6's placed 3 ft. apart; that is, two in each span, which at the same time served to support the scaffolding for the workers. Along the lower edge of the sloping partition a curb board was placed, but no other forms were necessary, the metal lath serving to retain the mortar in place until it had set.

No. 24 gauge "Self-Sentering" metal lath, made by the General Fireproofing Company, Youngstown, O., was used. This weighs 3.4 lbs. per sq. ft. and comes in sections 29 ins. wide and 11 ft. long. The ends were lapped 10 ins., and in adjoining sections the outside ribs were interlocked. This, combined with the irregular fitting necessary at ends of tanks and cutting along bottom of parti-

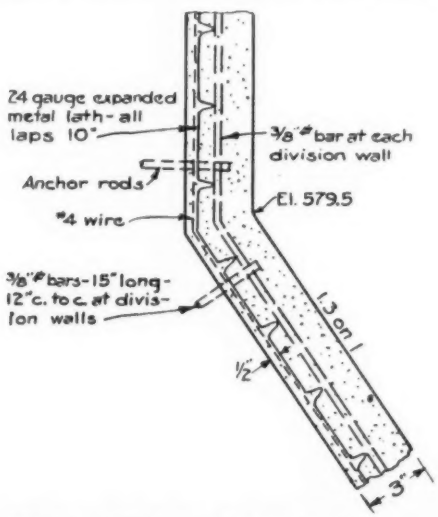

24 gauge expanded metal lath - all laps 10"
3/8" ϕ bar at each division wall
Anchor rods
El. 579.5
#4 wire
3/8" ϕ bars - 15" long - 12" c. to c. at division walls
1.3 on 1
1/2"
3"

FIG. 3—DETAIL OF PARTITION WALL.

FIGI. 4—LAYOUT OF CONTRACTOR'S PLANT.

FIG. 5—PLACING METAL LATH.

tions, required an excess area of 22 per cent.

Specifications called for 1 to 2 mortar tempered with 1 part of lime to 10 parts mortar. Actually, Palace Island sand and Universal cement was used, without lime, except in the case of the scratch coat, where 10 per cent of lime and a small amount of hair was added.

Description of Plant

The equipment used consisted of two No. 2 Cement Guns, manufactured by the Cement Gun Company at Allentown, Pa. No. 2 gun is the largest size manufacturned by this Company, and is capable of "shooting" 150 bags of cement per day

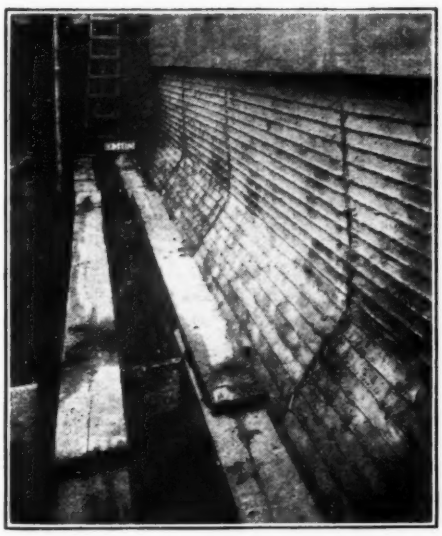


FIG. 6—SCRATCH COAT ON FLOW PARTITION.

(using the mix used at West 58th St.) This amount is equivalent to approximately 350 cu. ft. of mixed materials ready to be applied at the nozzle.

Two compressors were used to supply air to the guns. One compressor was a Chicago Pneumatic Company, 10x12, and the other an Ingersoll Rand, 8x10. The Chicago Pneumatic was belt connected to a 50 h. p. G. E. motor, having the following rating: 3 phase, 60 cycle, 220 volt, 124 A, 865 R. P. M. The Ingersoll Rand was belt connected to a 50 h. p. Crocker Wheeler motor, having the following rating: 3 phase, 60 cycle, 220 volt, 125 A,

FIG. 7—APPEARANCE OF FINISHED PARTITION WALL.

860 R. P. M. Two tanks approximately 3 ft. in diameter and 7 ft. high were used as air receivers. The main air line was 3 ins. diameter, W. I. pipe from which smaller lines to the guns were taken. The remainder of the equipment consisted in sheds for storage of tools and materials, scaffolding and forming lumber, covers for tanks and small tools. The compressors furnished air at 75 to 80 lbs. at the compressor, which gave about 35 to 45 lbs. at the nozzle.

The first set-up was as shown in Fig. 4 near the disinfection building. The sand was stored east of the laboratory and wheeled to the mixing shed. The

sand was not covered at all times and on several occasions became too wet for mixing. The major portion of tanks 1, 8, 9, 16, 2, 7 and 10 were gunned from this position. When work was reopened in 1922 the first gun was moved to the top of tank No. 6, and a second gun was placed south of tank No. 12, a mixing shed being built east of the car house, where the cement was stored, the sand being stored close at hand. After the third row of tanks was well along, the first gun was moved south of tank No. 12, and operated at this location until the work was completed.

Progress of Work

Work was begun about September 1, 1921, in tank No. 1 and continued till the middle of December. It was again started about the middle of May, 1922, and completed the end of July, 1922, or a total of six months.

Method of Operation

Work was begun about Sept. 1st, 1921, intank No. 1 and continued till the middle of December. It was again started about the middle of May, 1922, and completed the end of July, 1922, or a total of six months.

The cement was stored in weatherproof sheds, and the sand was stored in the open during most of the time. The sand was measured and mixed thoroughly with the cement and screened through a ¼ in. mesh screen before it was taken to the gun. The mixing was done "dry" —meaning that no water was added during mixing and the mix contained only moisture that was in the sand as it came to the job. During the progress of the work a quantity of sand was kiln dried and mixed with cement at the plant of the Cleveland Builders' Supply Company. This material was absolutely dry and could be machine mixed and stored in large quantities, thus saving the labor cost of hand mixing. This material was an absolute failure for use in the guns at the West 58th St. Plant—no satisfactory explanation why it did not work could be given. The mix was shoveled directly into the hopper of the gun and carried through the gun and hose with air at 35 lb. pressure. The application of water to the mixture was done at the nozzle, and the entire mixing was accomplished in a distance of 6 or 7 ins.

The scratch coat was troweled on and made just thick enough to fill the openings in the metal lath and thus form a backing for the gunite, as well as a key for the back coat. Twenty-four hours later the first gun coat was shot on, followed 24 hours later by the second gun coat, which served principally to even up the surface and was only ½ to ¾ ins. thick. Immediately after the second gun the wall was finished by screeding and floating to a smooth, even surface. After the wall had stood seven days, the forms were removed and the back finished, the upper portion by hand and the lower portion by gun. The back gun coat was not troweled. The clean-up consisted mostly in removing rebound materials from the bottom of the tanks. This was quite large in amount and was first removed in buckets, but later small hoists driven by gasoline engines were used.

Operating Force

The operating force consisted chiefly of a superintendent, who gave only part time to the work; a plaster foreman, who acted as superintendent when the other man was off the job; a lather foreman, engineer, plasterers, lathers and laborers.

The number of men varied considerably throughout the period of doing the work, but the following list of men is the average number to carry on the work when one or two guns are operated:

	One Gun	Two Guns
Superintendent	1	1
Lather Foreman	1	1
Plasterer Foreman and Asst. Supt.	1	1
Plasterers	3	6
Engineers (Compressors)	1	1
Nozzle Man	1	2
Nozzle Man Helper	1	2
Laborers (Building Scaffold)	2	3
Gun Man	1	2
Gun Man Helper	1	1
Laborers Mixing Material	2	3
Laborers Wheeling Sand and Cement	1	1
Laborers Cleaning	3	4
Engineer (Cleaning)	1	1
	23	35

Cost of Work

With excess area the job called for 12,000 sq. yds. of metal lath, and 10 tons pencil wiring and miscellaneous steel. The contractor's unit price on this was 77 cts. per sq. yd.

The net amount of mortar reqqired was 770 cu. yds. In this connection it should be noted that by actual test the cement gun method required 28.5 per cent excess material, due to rebounding, wastage, etc., as against 8.5 per cent estimated for

hand troweling, which is also reflected in the labor item for cleaning up. The cost figure on this came to $1.11 per sq. yd.

Lumber for scaffolding and forms, based on 6 reuses, amounted to 26 cts. per sq. yd.

The labor costs were kept in detail for each kind of work in each tank and are shown in detail by Table 1, together with average labor costs for the whole job. As the contractor was inexperienced in the use of the cement gun method, the cost on the first tanks done was naturally higher than that of later work. This was particularly due to improper apportionment of the different classes of common and skilled labor on the work, and the lack of judgment shown in placing materials and equipment, matters which were later corrected.

The cost of electric power for operating compressors and miscellaneous uses was about $1,200 for the job, or 12.5 cts. per sq. yd.

The guns were rented, as was also the compresser plant. Other equipment charges were hose renewal, gun repair and motor and compressor supplies. These were on a yardage basis:

	Per Sq. Yd.
Gun Rental	$0.101
Compressor Rental	0.170
Gun Repair	0.013
Supplies and Misc.	0.500
	$5.294

The summarized cost per square yard from above sources is as follows:

	Per Sq. Yd.
Metal Lath	$0.770
Mortar	1.110
Scaffolding	0.260
Labor	2,345
Power	0.125
Equipment Charge	0.784
Total	$0.784

The unit wages paid upon the work were, for common labor, 58 to 70c per hour, while lathers, finishers and plasterers received $1.10 per hour. Common labor was used to place the scaffolding.

The total amount paid the contractor was approximately $70,000, which means he received about $7.36 per sq. yd. Carefully detailed cost records were kept by the city from which the data of this article were obtained. They show that the cost, exclusive of overhead charges and contractor's profit, was approximately $5.30.

Summary

We found a number of unlooked for conditions and unusual factors in this work. For one thing, obtaining the use of the cement guns in the number and at the time required, and at what seemed a fair rental value to the contractor appeared to be a matter of some difficulty, although it would seem that the makers of this equipment should be interested in extending and popularizing this method

TABLE I—SHOWING COST OF LABOR PER SQ. YD. OF FLOW PARTITION WALLS WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

Tank	Scaffolding.	Lathing	Scratch	1st Gun	2nd Gun	Finish	Back Top	Back Bottom	Cleaning	Wrecking	Mixing	Total
1.....	1.180	0.845	0.094	0.177	0.126	0.114	0.258	0.180	0.222	0.065	0.8225	4.0835
2.....	0.093	0.280	0.119	0.151	0.115	0.110	0.365	0.219	0.310	0.070	0.499	2.331
3.....	0.105	0.366	0.214	0.168	0.080	0.131	0.084	0.114	0.345	0.061	0.405	2.073
4.....	0.142	0.400	0.096	0.150	0.099	0.110	0.090	0.084	0.292	0.064	0.387	1.914
5.....	0.156	0.360	0.095	0.140	0.096	0.105	0.119	0.182	0.326	0.050	0.409	2.038
6.....	0.182	0.399	0.116	0.126	0.092	0.140	0.164	0.190	0.338	0.062	0.369	2.178
7.....	0.227	0.405	0.111	0.161	0.123	0.094	0.299	0.238	0.260	0.069	0.283	2.270
8.....	0.354	0.540	0.109	0.196	0.115	0.111	0.340	0.205	0.209	0.055	0.319	2.553
9.....	0.315	0.405	0.130	0.152	0.118	0.102	0.287	0.223	0.297	0.055	0.282	2.366
10.....	0.238	0.490	0.110	0.162	0.124	0.108	0.190	0.103	0.426	0.100	0.435	2.486
11.....	0.114	0.365	0.100	0.118	0.085	0.131	0.175	0.155	0.314	0.045	0.406	2.008
12.....	0.183	0.396	0.100	0.150	0.090	0.084	0.110	0.254	0.328	0.067	0.387	2.149
13.....	0.207	0.360	0.108	0.124	0.132	0.111	0.124	0.120	0.375	0.057	0.425	2.143
14.....	0.299	0.340	0.086	0.122	0.100	0.121	0.136	0.105	0.323	0.070	0.396	2.098
15.....	0.270	0.414	0.105	0.170	0.095	0.105	0.131	0.124	0.392	....	0.379	2.185
16.....	0.370	0.440	0.148	0.184	0.124	0.120	0.257	0.237	0.300	0.066	0.424	2.670
Average	0.277	0.425	0.115	0.153	0.107	0.112	0.196	0.171	0.316	0.064	0.414	2.345
% of Total	11.7	18.1	4.9	6.5	4.6	4.8	8.3	7.3	13.5	2.7	17.6	100

of concreting. The plasterers by trade do not look with favor on this system, as being in competition with the long established trowel method, and it is difficult to secure their full co-operation on the work. We were much impressed with the necessity of having the gun work done by experienced men, and having the job properly supervised by some one who specialized in this line. An item not generally considered is the large waste of mortar. As pointed out herein, this amounted to over 28 per cent, as compared with about 8 per cent by the usual trowel method.

This work was done under the general supervision of Mr. Robert Hoffman, Commissioner and Chief Engineer, and immediate direction of J. Milton Heffelfinger, Resident Engineer, by the Bagnall-Taylor Company, as sub-contractors for the Masters & Mullen Construction Company of Cleveland, general contractors.

ECONOMICAL CONTROL OF CHEMICAL DOSAGE IN WATER FILTRATION PLANTS

By R. A. Maddock, in Charge of Water Purification, Room 6 City Hall, Charlotte, N. C.

One of the greatest opportunities to reduce operating expenses of water purification plants is in the control of chemical dosage. The point of application, agitation and hydrogen-ion concentration, all have an important bearing on economical coagulation and sedimentation, over which the operator usually has control. By careful and intelligent handling the hydrogen-ion concentration can be adjusted to the optimum pH value, which is necessary for complete, or nearly complete, precipitation of the aluminum from the alum added to the water, which means less chemicals will be required for a given bacteria, turbidity or color removal. This point has not been very definitely established as yet, and the reports from various sections would indicate that it varies for different waters.

Very often the chemicals are introduced into the main just before reaching the sedimentation basin, and while this method is satisfactory under most conditions, it will at times be found an advantage to apply the chemicals at some other point or at several points. If the water to be treated contains much heavy sediment, it would be a waste of money to apply the chemicals before the water enters the basin, since a large portion would be carried down with the heavy particles soon after entering the basin. Under conditions of this kind it would often be found advantageous to let the heavy particles settle out in the first part of the basin without the aid of coagulation, and apply the chemicals at or near the center of the basin if capacity will permit.

We know that the temperature of all surface waters fluctuates and that temperature has a marked effect upon coagulation, which is another reason that provisions should be made to apply the chemicals at different points. The proper time to install provisions of this kind is when the plant is built, but, with all kind feelings, I am prompted to say that we have many designing engineers who are unfamiliar with plant operation. On a great many occasions the credit for a plant that is operated with apparently good results has gone to the engineer when it rightfully belonged to the plant operator.

In many plants it is necessary to use quicklime (calcium oxide) in connection with sulphate of alumina. To get the best results from its use it should be slacked very carefully. Hot water will be found best for this purpose, as the temperature during slacking should be as high as possible.

A method is being installed in the new water treatment plant at Newark, O., which was designed by Charles P. Hoover, assisted by A. R. Holbrook, which consists of excess treatment with lime, soda ash and alum, combined. This excess treatment will be obtained by overdosing a portion of the supply and subsequently mixing it with a larger and untreated part of the supply. The amount to be treated with excess amount of chemicals will be approximately 25 per cent, immediately after which it will be vigorously agitated for about five minutes. This 25 per cent portion will then be mixed with the 75 per cent untreated portion in a baffled mixing tank, through which the water will have a carrying velocity of 0.4 ft. per second, the detention period being 60 minutes. The entire body of water will then be passed to concentrating tanks equipped with Dorr thickeners, where the water will remain for about 22 minutes. It is pointed out by Mr. Hoover that the extraction of as much as possible of the precipitate or sludge in the thickeners before the water passes to the sedimentation basin will lessen the accumulation of sludge at the entrance of the basin and

thus make the basin utilizable to its full capacity at all times. It is believed that this method will prove to be economical as well as efficient.

While the carbonation of water as an aid to coagulation is more or less in the experimental state, it has been reported on very favorably.

John R. Baylis, Principal Sanitary Chemist, water department, Baltimore, Md., has recently reported that at Baltimore the addition of a small amount of sulphuric acid to the water before, or at the same time as the alum, has aided coagulation very materially. He reports that several trials have been made under operating conditions, with results that show considerable saving in alum. From this experimental work Mr. Baylis draws the conclusion that in most places an acid alum could be used with better results than basic alum, which is being used almost universally.

The waters in some lakes and a few rivers, especially at certain seasons of the year, are comparatively free from coloring and suspended matter, and could be treated very successfully, the writer believes, with a method he used at Oshkosh, Wis., for about two years, and which resulted in a large saving of chemicals. Oshkosh gets its water supply from Lake Winnebago, which during several months of the year has little coloring or suspended matter. The method used during these favorable periods is described as follows:

Discontinue the application of chemicals to the sedimentation basin and instead apply a strong solution of sulphate of alumina to the quiescent water in a freshly washed filter bed and allow to stand long enough to break up and form a mat of aluminum hydroxide of a uniform thickness. Some will remember a few years ago when asbestos was tried out to produce a filtering mat on the surface of the sand, but was a failure, due to inability to get a uniform thickness. The amount of sulphate of alumina used depends upon the strength of the solution as well as the area of the sand bed. This solution can be applied through an ordinary garden hose, but was applied at Oshkosh through perforated pipes placed over the filters at regular intervals. This method does away with any chance to get alum in the filter effluent, and provides a good mat from the very beginning of each filter run. The writer believes this method could be successfully used at a great many plants—at least periodically.

It has been observed at some few places that chlorination preceding the addition of alum has very greatly aided coagulation in removing both suspended and coloring matter. The application of chlorine prior to filtration is, the writer believes, in many instances good practice, since where bacterial removal alone is sought by the use of alum, to produce an effluent from the filters that will compare favorably to the American Public Health Standard, the substitution of chlorine for alum will be found an effective substitute.

Should a plant operator be classed as careless or incapable because he does not strive to produce a low bacterial count in the effluent from the filters, but who regulates his chemical dosage so as to get a water that is free from suspended matter and depend on chlorination for satisfactory bacterial count? In a great many cases the answer to this question should be "no." Many of those who favor treating the water with sufficient chemicals so as to obtain an effluent that will pass the United States Health Standard before chlorination, seem to think that it is unsafe to rely upon chlorine to do its full and just share. This is probably true for the plant that is inefficiently operated and that relies on one chlorinating outfit. All plants should have two complete chlorinating units with a supply of all extra parts on hand so in case one machine goes down and out there need be no delay or interruption in the sterilization of the water. In the larger plants both chlorinators should be allowed to run with the dose divided equally between them.

Proper installation of chlorinators operated in multiple units is all that some of our larger cities depend on for the successful purification of their water supply. Of course chlorinators require intelligent supervision the same as any other mechanical device.

Some few engineers go so far as to contend that chlorine should not be used at all. From the standpoint of economy it seems to me that it is poor business as well as poor judgment to spend four dollars to purify a million gallons of water without the use of chlorine when the same standard of purity can be maintained for two dollars by using chlorine in connection with coagulation and filtration. On the other hand, to insure a constant supply of pure water, depending at all times entirely on coagulation and filtration, would in most cases require a trained man on the job every hour of the day and

night, which is a condition found only in our largest cities.

In a number of cases chlorination has enabled the rate of filtration to be increased. This increased capacity, which otherwise would have called for additional filter units, has been obtained without any further costs. It is constantly being demonstrated that it is possible successfully to operate water purification plants and to obtain the desired clarification and color removal by the use of alum, and rely on chlorination for bacterial removal.

The writer believes that using chlorine on the side of safety is the proper thing to do when treating such waters as those that show a satisfactory bacterial count when treated to produce 100 per cent clarification and a satisfactory color removal. However, I believe that in limiting the use of chlorine only as a measure on the side of safety, we are not making proper use of the greatest instrument ever placed in the hands of water purification engineers.

We plant operators are too often inclined to accept the other fellow's word for it that a certain thing will or will not work. The writer believes this in many cases to be decidedly wrong since the conditions under which the other fellow is working may be entirely different from our own. At Charlotte we have been able to reduce operating expenses about $6,500 per year.

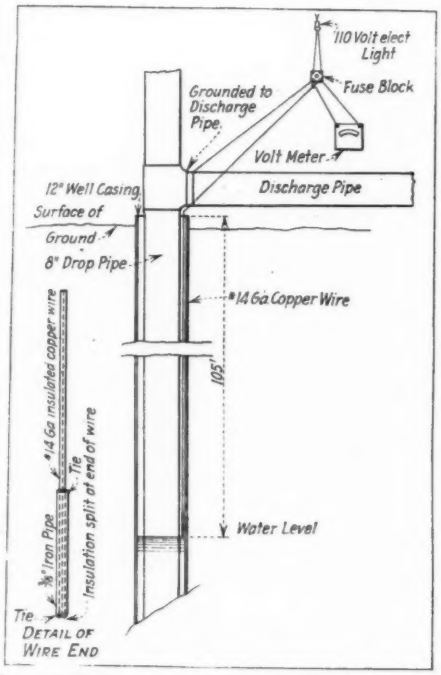
The foregoing matter is from a paper by Mr. Maddock before the recent meeting of the North Carolina section of the American Water Works Association.

METHOD OF MEASURING DEPTH OF WATER IN WELL

By Jent G. Thorne, Consulting Engineer, 317 Howe's Block, Clinton, Iowa.

During the testing of the new deep well recently drilled in Dewitt, Iowa, the height of the water in the well, both before pumping and while pumping, was measured by means of an electric current.

A No. 14 gauge, rubber-insulated copper wire was fitted on one end with a ⅜-in. iron pipe 2 ft. long, to act as a weight, securely tied to the wire. The wire was cut off about an inch below the end of this pipe and the insulation was allowed to extend slightly below the end of the copper wire. The other end of this wire was connected to one terminal of a fuse block, while another wire was run to the second terminal on the fuse block and grounded on the iron drop pipe. From the third and fourth terminals of the fuse block a connection was made to the 110 volt city electric current. A volt meter was connected to the first two terminals of the fuse block to indicate when the circuit was made. While the wire was being lowered into the well the hand on the volt meter stood at zero until the water was reached, when it would move up four or five points. By working the wire up and down several times the exact



SKETCH SHOWING APPARATUS USED TO DETERMINE ELEVATION OF WATER IN DEEP WELLS.

point was indicated where the hand on the volt meter would commence to move. In this way the exact height of the water in the well was measured very quickly. A string with a wooden float was used, but was not successful on account of the scarcity of room between the drop pipe and the well casing. An electric bulb was tried instead of the volt meter, but did not give results. The whole apparatus is very simple and easy to install, and gives the results desired without question of their being correct.

RELINING STEEL COAL HOPPERS AND BUNKERS WITH GUNITE

By James G. Melluish, Consulting Engineer, 222 Unity Bldg., Bloomington, Ind.

The power plant of the Bloomington & Normal Railway & Light Company, is located in the city of Bloomington, Ill., adjoining the right-of-way of the C. C., C. & St. L. R. R., between Madison ntreet and ter tube boilers is stoked by a complete Roosevelt avenue. Its battery of ten walayout of automatic stokers. Some months ago the steel coal hopper and overhead coal bunkers became corroded and eaten through by the action of the sulphuric acid from the soft coal used in this plant.

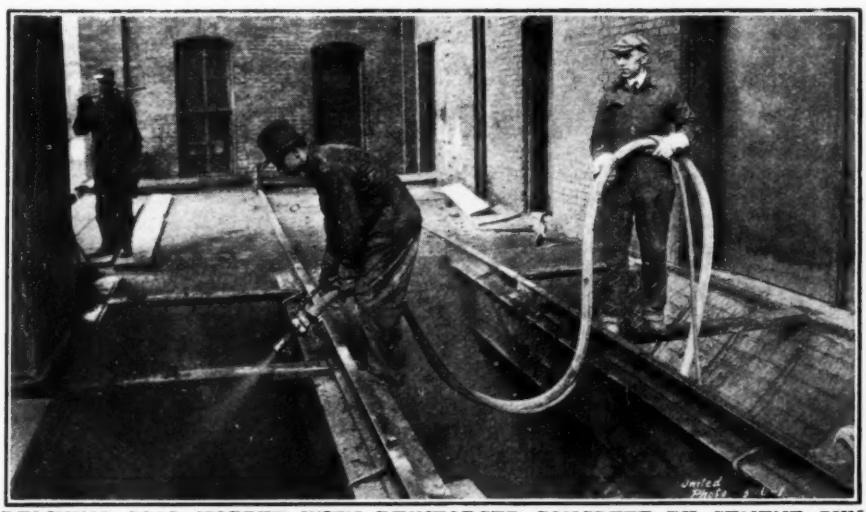
After considering the cost of repairing by means of relining with steel the bunkers and hoppers, or of entirely renewing them, it was determined to adopt a different method, namely, of relining the bunkers and hoppers with reinforced concrete. The work was started on Jan. 10, 1922, and finished on Feb. 21, 1922. The operation of the plant was continuous throughout this period and no interruption or inconvenience was occasioned, and one of the determining factors in adopting this method was the expectation that no interruption of the plant would be occasioned.

The contract for the work was taken by the Cement-Gun Construction Company of Chicago, Ill., under the supervision of D. G. Walace, Operating Engineer for the Bloomington & Normal Railway & Light Company. For the construction company Mr. Frank Beeby, its Chief Engineer, designed the reinforcement and made inspections.

The method of reconstruction and lining was as follows: Cast iron bin gates were made and installed, and also a reinforcing plate 18 ins by ¼ in. steel put around the bottom of each bunker. A large number of rivets were found to be burned out of the bunkers, and bolts were therefore extended through into the concrete, as well as being fastened to the stiffening beams on the outside of the bunker.

The hopper on the outside of the building was reinforced with American Steel & Wire Company's reinforcement No. 0.049 and with ⅜-in. sq. rods. The bunkers on the inside of the building were likewise reinforced.

The concrete beam was extended across between bunkers, and also the beam effect on the sides, in order to relieve the strain on the old bunker sheet and practically take all of the weight indirectly off the concrete lining.



RELINING COAL HOPPER WITH REINFORCED CONCRETE BY CEMENT GUN PROCESS AT BLOOMINGTON, ILL.

The concrete lining varies in thickness from 1½ in. to 2½ ins. on the general covering and increases at the beam points to 4 ins. to 6 ins. The steel work was very carefully bent, and also the steel plates were thoroughly cleaned off with sand blast before being covered with cement. All steel supports and bunker columns were thoroughly inspected and cleaned off in order that the concrete beams would have a rigid bearing on the vertical steel supporting columns.

The concrete mixture for this reconstruction was 3½ to 1. Lincoln (Illinois) Sand and Gravel Company special washed, cleaned, dry torpedo sand was used and Alpha Portland cement. The cement was applied with cement-gun, under pressure of approximately 55 lbs., as shown in the accompanying view, where deposition of concrete through the gun nozzle is shown in its application to the coal hopper.

The coal bunkers, and particularly the coal hopper, are subjected to very rough treatment; coal is dropped from regular steel hopper coal cars directly into the Service Company's hopper, then elevated and dropped into the coal bunkers, the coal having first been prepared for the stoker. After several months' usage and tests an inspection of the concrete lining shows there has been no noticeable abrasion of the surface, and the whole work is regarded as entirely successful.

TREND OF HIGHWAY TRANSPORT EDUCATION IN THE UNITED STATES

By Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

What is included in highway transport education? I conceive that highway transport education should cover the fundamentals of the science, art, economics and business of the transportation of passengers and commodities over highways.

Courses in this field will be taken by men looking forward to the profession of highway transport engineering, the motor vehicle industry, and the businesses of traffic management and highway transport.

In the opinion of some, highway transport may not be considered as belonging to the field of technical training and education. On sober thought, however, it will be seen that this branch of knowledge comes well within the classic definition of engineering embodied in the Royal Charter of the Institution of Civil Engineers of Great Britain, which in part is as follows: "The art of directing the great sources of power in nature for the use and convenience of man as the means of production and of traffic in states both for external and internal trade."

From the standpoint of highway transport business, courses in this field will be taken by men who desire to equip themselves efficiently for the positions of business administrators, dealers, salesmen and advertisers in the motor vehicle industry, and executives, operators, traffic managers, motor truck fleet managers and dispatchers in the commercial field of highway transport, and in the closely related fields of railway and waterway transport.

Demand for Highway Transport Engineers

What is the demand for highway transport engineers and men equipped for highway transport business? In May, 1920, the First National Conference on Highway Engineering and Highway Transport Education held in Washington, D. C., unanimously adopted the conclusion that 4,000 men should be trained in highway transport each year in universities for the positions heretofore enumerated. Many have misinterpreted the meaning of this conclusion. Emphasis should be placed on the words, "*should be trained.*" The representative committee framing this conclusion had in mind the economic and efficient utilization of highway transport in the transportation system of the United States. They did not say that there was an immediate call for 4,000 trained men each year, but they did imply that the country would be benefited by having 4,000 men trained each year and their services utilized in the field of highway transport.

What is the present situation in regard to the demand for highway transport engineers and men trained in the business of highway transport? While it is true that the University of Michigan, which first instituted courses in highway transport and is in the heart of the motor vehicle industry, has no difficulty in placing its men in the highway transport field, the number of well paid positions available in this field at the present time is comparatively small. Why does this condition exist? The answer is simple. The potential users of men trained in highway transport are not educated to the value of the services of such men.

Allow me respectfully to suggest that the Highway Education Board devote at least as much time to the spread of propaganda among potential users of men trained in highway transport as in encouraging the universities throughout the United States to establish courses in highway transport. A herculean task must be consummated in this field if we are to see highway transport take its proper economic place in the transportation system of America.

Many highway departments are not properly designing the highways for even

immediate future traffic because their personnel does not include men who have had a proper training in highway transport to have a vision and adequate background which will enable them to diagnose the probable development of traffic on a given highway, or, in other words, to make the prerequisite of economic highway design a highway transport survey, which embodies all investigations in the field and office which are necessary efficiently to estimate the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts.

A new Division in State Highway Departments. The establishment of a sound highway transport business is based on results of an exhaustive transport survey. Why should not the same policy be followed when the economic investment of milions of dollars in highway improvements is at stake?

In order that highway transport surveys should be properly conducted and adequate provision be made for the economic design, construction and maintenance of highways, each State Highway Department should create a Highway Transport Division. The duties of this division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of highways and their efficient use by pedestrians and all classes of vehicles. One of the most important functions of such a division would be to make highway transport surveys as preliminary to the design and re-design of state highways, the determination of efficient methods of maintenance, and the formulation of recommendations pertaining to efficient traffic and transport regulations.

Men asigned to a Highway Transport Division should be experienced highway engineers who have or are rapidly acquiring a knowledge of the following subjects: Highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities, and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

In order to secure and retain the services of engineers qualified to occupy responsible positions in a Highway Transport Division, it will be necessary for State Highway Departments to pay salaries ranging from $3,600 to $10,000. Not only will the economic law of demand and supply in the highway engineering field necessitate the payment of proper salaries to engineers trained and experienced in highway transport, but highway departments will be forced to compete with the commercial demand for the services of such men.

Motor truck manufacturers' organizations are in a chaotic condition from the standpoint of the proper utilization of men trained in highway transport. Why? In general, they have followed in the obliterated footsteps of companies manufacturing highway machinery and materials. The latter companies originally established departments which were advertised to give unbiased consulting service to their customers. Motor truck companies established a few years ago highway transport engineering departments, and advertised to make a complete highway transport survey covering the requirements of a prospective user of motor trucks and to give unbiased advice pertaining to the purchase of equipment. What was the result? In the first place, it was found impracticable to divorce unbiased opinion from the commercial interests of the organization represented, and soon prospective customers began to realize this self-evident fact. Second, disastrous conflict arose between the highway transport engineering department and the sales organization, a natural result to anyone familiar with the interrelationship existing between the activites of such departments. What was the final outcome in the case of companies manufacturing highway materials and machinery? The natural logical conclusion was reached that the sales organization should contain men trained in the fundamentals of highway engineering practice and the efficient use of the machinery or materials manufactured by a given company, and that advice should be restricted to the efficient and economic utilization of the machinery or materials manufactured. The results have been beneficial not only from the standpoint of the commercial organizations concerned, but also from the standpoint of the general highway engineering profession and the public which ultimately benefited by increased efficiency. All are familiar with the efficient services rendered along these lines by such commercial organizations as The Asphalt Association, The Barrett Company, The Granite Block Manufacturers' Association,

The Jennison-Wright Company, The National Paving Brick Manufacturers' Association, The Portland Cement Association, The Texas Company and many others. I predict that in the near future the motor truck manufacturers of this country will see the light and follow in the footsteps of the closely related companies who have already passed through the transition stage. Concretely stated, the sales organizations of motor truck, tractor and trailer companies should be composed of men trained in the fundamentals of highway transport and the efficient use of the equipment manufactured by the company which they represent.

Failures of highway transport enterprises are occurring every day, due to a lack of knowledge of the fundamentals of the economics, science and art of highway transport. It is reported that 90 per cent of all highway transport companies doing business with New York City as a center fail within three years after entering this field. While 50 per cent may fail, due to cut-throat competition by fly-by-night companies, it is conservatively estimated that at least 50 per cent fail because of lack of knowledge of the A B C's of efficient highway transport business methods, cost accounting, management and the operation and maintenance of equipment. The Highway Education Board has a big task before it in bringing to the attention of groups of business men or capitalists, operators and prospective operators of highway transport, the necessity of having connected with their operating organizations men who are thoroughly trained in the methods of highway transport, the interrelationship of highway, railway and waterway transport, highway transport legislation, the fundamentals of highway transport cost and record systems and the principles of highway transport management, together, of course, with a knowledge of the mechanism, operation and maintenance of motor trucks, tractors and trailers.

We find a satisfactory status relative to the development of highway transport education in the universities throughout the United States. In some institutions the logical development occurs by the men having charge of highway engineering courses giving courses in the related field by highway transport. In other institutions, such courses are offered by the Department of Economics or Business Administration. If these departments are to teach highway transport efficiently, the instructors must have a knowledge of the fundamentals of the economics and science of highway engineering and practical highway transport. It is expected that notable developments will take place along these lines, especially when authoritative texts are available. We have a development in the main of undergraduate instruction in the fundamentals of highway transport. In this connection, allow me to emphasize strongly a recommendation which I have made at the University of Michigan that all engineers should be required to take, as a part of their curricula, a fundamental course in "*Transportation*," which would cover the economics of the utilization and operation of highway, railway and waterway transport.

Naturally, developments in the graduate field have been slow, due, first, to a lack of demand by students for such courses; second, because there are few instructors who feel capable of giving graduate instruction in this field; and, third, due to a lack of the necessary financial support by institutional administrators.

As soon as the demand from potential users develops it will be necessary materially to speed up the training of mature men as well as college students in the fundamentals of highway transport. It is my belief that the Graduate Short Period Course offers the most efficient method of training mature men who may be connected with motor truck or trailer manufacturers' promotion and sales organizations; traffic departments of plants, factories, wholesale and retail stores, steam and electric railroads and waterway transportation companies; highway transport enterprises, and state, county or municipal highway departments. Such courses in the field of highway engineering and highway transport are developing rapidly at the university which I have the honor to represent. Eighteen of these courses are given in periods of two weeks each during the months from December to March inclusive. Each course consists of 30 lectures, or the equivalent thereof, and counts as two hours credit towards the total of 24 hours required for the Master's degree. Persons of mature age, who do not hold collegiate or technical degrees, may register for these courses as special students, not candidates for a degree. In the first year, 1919-1920, when such courses were offered at the University of Michigan, the attendance was 29. In 1920-1921 the attendance increased to 45, while in 1921-1922, 94 men were registered in these

courses, the average age of the men being 27 years, ranging from 22 to 54 years. They came from all over the United States and some from foreign countries. They represented universities; state, county and municipal highway departments, consulting engineers' offices; contractors' organizations; companies manufacturing motor trucks, highway machinery and materials, and from the field of highway transport business. About 50 per cent of these men were graduate engineers, registered in the Graduate School for the Master's degree, 16 Master's degrees being awarded in June, 1922, to men with a major subject in highway engineering or highway transport. The other 50 per cent were mature men in practice who had not had a college training. It should be stated that all men are on an equal footing in these graduate courses, and take an equal part in the discussions of the many subjects considered.

In this connection I wish to reiterate my recommendation at the 1920 conference that at least ten universities, located in different geographical sections of the United States, offer Graduate Short Period Courses covering the various phases of highway transport, if they are financially able to engage the proper personnel and provide sufficient equipment for carrying on graduate work in this field. It is earnestly hoped that this recommendation may be favorably considered by administrative bodies of some leading universities, and that they will adopt the broad-visioned policies of Dr. Marion L. Burton, President of the University of Michigan, and the Board of Regents, who have provided adequate personnel and physical equipment for the efficient development of graduate instruction and research in highway engineering and highway transport as shown, first, by their action in establishing a chair of Highway Engineering and Highway Transport, and appointment of two assistant professors, a librarian of the Davis Library of Highway Engineering and Highway Transport, an instructor and three assistants in Highway Engineering, and, second, in their assigning two floors of one wing, 65 ft. by 225 ft., of the new $750,000 Engineering Building to the Division of Highway Engineering and Highway Transport.

The foregoing paper by Prof. Blanchard was presented at the second National Conference on Highway Engineering and Highway Transport Education held in Washington, D. C., on Oct. 26, 1922.

HINTS ON HAULAGE OF LEAN MIXTURES OF CONCRETE

By C. C. Wiley, Asst. Prof. Highway Engineering, University of Illinois, 201 Engineering Hall, Urbana, Ill.

The wet haulage of rich mixtures of concrete, such as are used for concrete roads, has met with unusual success. The haulage of the leaner mixtures, however, has not been as satisfactory, but even such mixtures can be hauled with fair results if some precautions are taken.

During the past summer in the city of Champaign, Ill., it was desired to lay a 6-in. concrete foundation for a brick pavement. The contractor had been laying concrete pavements from a central mixing plant and desired to use this method on this concrete base.

The specifications called for a 1:3:5 mixture. The aggregates were sand and gravel, both of which were fairly well graded, but the sand especially tended towards coarseness. The resulting concrete, therefore, was somewhat harsh and difficult to finish.

The concrete was hauled in Lee bodies mounted on Ford trucks. The distance was 2.6 mile, all on fair to good brick pavement. Every batch received was mixed at least one minute and many of them twice as much.

At the start of the work it was found very difficult to spread the concrete and secure a surface that could be finished; in fact, some 20 ft. of the concrete had to have added to it a thin grout coat to fill up the spaces between the coarse aggregates and make the surface smooth and solid.

It was found that a wet consistency would come on the job with 2 or 3 ins. of water on top of the load and the bottom of it very dense and solid, necessitating the use of a pick to get it out. On the other hand, dry mixtures would be more or less solid all the way down and were too harsh to move into place and finish. After a number of trials the following method was developed:

1. The consistency such that about 1 in. of water stood on top of the concrete when it reached the job.

2. The truck was backed close to the concrete in place so that the new load was discharged on top of that already delivered. This pile was then pulled forward into place.

3. In dumping the truck, care was taken that the body should, on the first attempt, swing to its full unloading posi-

tion in order to give some inertia to the contents, which almost invariably threw the entire load out of the body.

By following this scheme carefully it was found entirely possible to get reasonably good results. If a batch came a little too wet, the slush became reunited as the mass of concrete was pulled forward into place and so caused little difficulty. If a batch came too dry, the end of a hose was inserted in the pile and a very gentle stream of water admitted. This seemed to percolate through the pile and reduce its consistency without washing out the fine material.

The surface of the concrete was struck off with a strike-board and then finished by means of long-handled wood floats. The finished surface was nearly as smooth and free from porous places as a concrete pavement, although not quite as evenly finished. It was found that belting was of little service.

MAINTENANCE OF EARTH ROADS WITH CINDERS AND COLD ASPHALTIC OIL IN BOROUGH OF QUEENS, NEW YOR CITY

Considerable interesting experimental work has been carried on in recent years by the Borough of Queens, with types of pavements which depart materially from local prevailing practice.

One of the most satisfactory results have been in the maintenance of dirt roads with cinders and cold asphaltic oil, as described by Messrs. E. E. Butterfield and Fred H. Shepheard.

There are between 600 and 700 miles of dirt roads in the Borough of Queens, which in a rapidly developing community must be kept open to traffic and which should be in condition to receive more varied and heavier traffic. In the winter and spring many of these roads were formerly impassable. The treatment these roads now appear to approach the stability of a macadam pavement and fur- of these roads with cinders and cold asphaltic oil has changed all of this and thermore, to retain this stability for at least one year which is as far as our experience goes..

The method which was somewhat improved in 1921 is as follows: The dirt road is honed and shaped (Ford Tractor and Jumbo Road Machine), the cinders are then spread by laborers with coal scoops. The cinders are then slightly compacted by a short rolling with 10-ton roller. The asphaltic oil is then applied and the roadway is given a final and thorough rolling. The result is a firm, smooth surface. In 1920, we used 7,000 tons of cinders for this purpose with most satisfactory results and so few of the roads required treatment after the winter of 1920-1921 that in the season of 1921 we have used 23,000 tons of cinders, corresponding to about 25 miles of roads, up to November 1st. The cost in 1920 was $0.27 per sq. yd. and in 1921, $0.258, wages being the same for both years.

PATCHING ASPHALTIC PAVEMENTS IN ZERO WEATHER

A method of repairing asphalt pavements during the winter months, when municipal and county asphalt plants usually are closed down, has been evolved with success by Charles L. Harrison, engineer of street repairs at Cincinnati.

The old asphalt pavement is removed from the streets and hauled to the yards during the regular working season, the pavement being broken down to approximately 2½ ins. The heating plant consists of 4 horizontal, 4-wheeled tar kettles, each of 100 gal. capacity. The old asphalt, broken to proper size, is placed in the kettles in the afternoon and the fire started at 5 o'clock the next morning. Four or 5 gals. of water are added and the covers are placed on the kettles, after being allowed to steam for half an hour the mixture is turned over with heavy bars, is spaded at one end and then allowed to steam again. The operation is repeated until at the end of 3 hours the water has evaporated and the mixture is ready for use at a temperature of 325 to 375 degrees Farenheit. It is then transferred to another kettle, under which a hot fire has been built, and is hauled therein to the street where it is laid in the same manner as "new stuff," except that it is tamped into place instead of being rolled. The 4 kettles are never allowed to be more than half full, as the mixing cannot be done in an economical manner if the kettles are full.

The force engaged in breaking, heating and laying the asphalt in Cincinnati consists of only the 7 men who are kept during the winter as the nucleus for the spring force and a driver for a 2-horse wagon. No additional bitumen or dust filler is added to the old asphalt and the cost is slightly less than the average cost per square yard for repairs with new material.

Construction News and Equipment

REGULATION OF OVERLOADING OF MOTOR TRUCKS

By David C. Fenner, Manager Public Works Department, International Motor Co., 25 Broadway, New York, N. Y.

(Editor's note: That the motor vehicle industry favors proper regulation of truck loading is emphasized in the following paper presented by Mr. Fenner at the recent joint session of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association.)

Effective regulation can be accomplished only after careful investigation and determination of the direction and amount of deviation from standards of normal practice. When we attempt to determine the facts regarding the loading of motor trucks we are handicapped by the lack of a standard which can be used as a practical basis of comparison.

A motor truck is a carrying tool, but not necessarily a measuring tool. It should be placed in the same general classification with the shovel and the wheelbarrow, and not with the quart and peck measure and the bushel basket.

The overloading of motor trucks is due in part to the improper basis of rating and classifying the motor truck chassis in terms of the manufacturer's rated pay load capacity. The user soon learns that this rating really does not mean anything. He purchases a motor truck chassis, attaches a body which may or may not fit either the chassis or the commodity to be carried and he then loads this truck to suit himself.

Select Chassis to Fit Commodity and Body

It would seem, indeed, that the motor truck body is the real measure of capacity which determines the size of chassis, which must be used to carry it, loaded with the commodity to be hauled.

In the sale of motor transportation, the successful salesman conducts a careful survey, the results of which convince the customer that a certain type, size, capacity and weight of body is necessary to fill his transportation requirements. He sells his customer this particular type, size, capacity and weight of body, and then, and not until then, is he in a position to sell the customer the proper type and size of chassis to carry this body loaded to capacity with the particular commodity that it is purchased to haul.

The large number of misfit motor trucks on the road today are the best possible examples of the other method of selling the motor truck chassis first and allowing the customer to put on the chassis any old body and load it in any old way.

Each chassis when it leaves the manufacturer's plant has a definite rated capacity for both the body weight and the weight of the load. If a particularly heavy body is mounted, or if various forms of auxiliary power devices are mounted in addition to the body and the dead weight of the body and these power devices exceed the body weight allowance determined by the chassis manufacturer, the pay load capacity must be reduced by the amount of this excess. In the case of dump bodies with hoists and transmission power take off for driving them, power-driven winches, pumps, air compressors and various other forms of auxiliary power devices, this excess weight is a considerable amount, and in many cases overloading would be reduced if a larger capacity chassis were used.

Caution Plates

Manufacturers have suggested that state motor vehicle commissioners should refuse a state motor vehicle license for any truck which is not equipped with a stamped with the actual weight of the manufacturer's caution plate properly chassis, body and load capacity.

Manufacturers are now proposing to go a step further and indicate on this plate the maximum allowable gross load for the front axle, the maximum allowable gross load for the rear axle, the maximum allowable speed and the distance in which the vehicle loaded to capacity can be stopped with each set of brakes operated independently with the vehicle running at the above maximum speed on a hard, dry, level roadway. The information on this caution plate will give the owner the data he needs for painting the weight and carrying capacity on the sides of the vehicle to comply with the

local state law. It will also enable the local enforcement officer to check up the distribution of weight between the axles, the maximum speed, and the condition of the braking system. A similar plate for use on homemade trucks can be issued by the state motor vehicle department. The information contained on this plate will prevent the operation of improper trucks and force the proper operation of good trucks. It will put the penalty for poorly adjusted brakes and steering connections directly up to the operator, where it belongs.

Some states are considering the suspension of a driver's license for three months as a penalty for faulty brakes.

Excuses for Overloading

Let us consider briefly the cause of reasoning which the owner follows as an excuse for overloading:

1. Beating the law.

2. Beating the state out of the proper amount of license fees.

3. Beating the rates of a competitor.

4. Beating the purchase price of the truck.

5. Wilful, persistent overloading in the face of all the facts.

Let us also briefly consider the result of these practices:

1. The man who overloads to beat the law ultimately runs afoul the local enforecement officer. The lightest penalty, if any, forces him to leave his excess load alongside the highway and the heaviest penalty forces him to leave his truck and its load with the state authorities until such time as his case comes before the court and is decided. In some cases this may require from six to eight weeks. In either of the above cases both the owner and tne operator are subject to fine and suspension of license.

2. The man who overloads to beat the state out of the proper license fee will ultimately have to forfeit his low rating license and the money which he paid for it, and be forced to take out a new license based on the gross weight which the truck was carrying at the time of his arrest and at the higher fee. Under the new license, however, he will not be allowed to carry more than the manufacturer's rate of capacity for the vehicle and its tire equipment.

3. The man who overloads to beat the rate of a competitor finds the practice unprofitable and ruinous in the long run. He does not benefit himself in any way. Rather he is benefitting his customer ot whom he makes a present of the depreciation on his equipment.

4. The man who overloads to beat the purchase price of his truck or say, rather, to take advantage of the "overload capacity" offered by some truck salesmen is up against the general law of averages. In the end he gets just about what he pays for and no more. You can be sure that the owner who follows this practice keeps no operating costs that are worthy of the name.

5. The man who persists in wilful overloading in the face of all the facts is a menace to public safety, and should permanently be refused either a vehicle or an operator's license. He has forfeited his right to the use of the highway and a few less of his kind on the highway will be a distance benefit to highway transportation.

Allow me to quote from a statement recently issued by Mr. Joseph F. Whelon, one of the most successful and progressive professional truck operators in New York City:

"With regard to the perpetual statement that the regulation of loads to the manufacturer's rated capacity would put the truckman out of business, I would say that this is not so. Such regulation instead of putting truckmen out of business would help them materially. If it did nothing else, it would bring to a halt the activities of the irresponsible operators who have no regard either for their mortgaged equipment or for their legitimate competitors.

"If truck loads were regulated it would mean that prices could be standardized, and that much equipment that is now idle might be operated at a fair profit because additonal trucks would be needed to carry the freight formerly piled haphazardly upon two or three long suffering and much abused vehicles."

Investigations conducted in some of our states show that the light and medium capacity vehicles are overloaded to a greater extent and in greater numbers than the heavy capacity vehicle. This indicates the importance of restricting loads per inch width of tire per wheel and per axle. We must recognize the four clases of tire, pneumatic, cushion, solid rubber and metal for regulating speed and the determination of license fees according to wheel load. We must

restrict the minimum thickness of solid and cushion tires when measured between the tire flange and a flat metal surface on which the wheel stands. We must also take into account the condition of tire.

The safety of the public, the preservation of the highway, the economy of vehicle operation, the status of the operator and the successful and economic development of highway transportation all demand that the practice of overloading should be discouraged, forbidden, prohibited and stamped out completely.

Let every week be a safety week in which we conduct a campaign against overloading. If you are a truck owner and operator, give your trucking department very definite insruetions regarding proper loading of highway vehicles. If you purchase your trucking on a rental basis, refuse to patronize those professional truckmen who persist in overloading.

Put it up to your local motor truck association to stop this practice of overloading or take the consequences of a concerted action of the local automobile owners' asociation and the local chamber of commerce to report to the enforcement officers every truck which shows the slightest evidence of being loaded beyond its capacity.

Let us take all the pleasure and the satisfaction out of overloading. Then the chap who has been overloading just to beat the game will quit, and the chap who is really forced by circumstances to haul more than the rated capacity of his present vehicle will either buy a larger vehicle or a semi-trailer and omunt the front end of this trailer on a fifth wheel attached to the frame of his present vehicle over its rear axle. By this means he can double the capacity of his present vehicle, and by distributing his gross load over six wheels, four of which are rolling and only two driven, he can keep within the wheel weight restrictions of the state law and the manufacturer's rated capacity of the truck, help to preserve the safety of the public and the best interests of highway transportation.

The motor vehicle industry stands solidly behind the rigid enforcement of the provisions of the Proposed Uniform Vehicle Law and the existing state laws. It condemns overloading and overspeeding unreservedly, and will co-operate actively in every movement to regulate loads and speeds of motor trucks on the highway.

NEW LINE OF SMALL VERTICAL BELT DRIVEN AIR COMPRESSORS

The Ingersoll-Rand Company, 11 Broadway, New York, announces a new line of small vertical belt-driven air compressors known as Type Fifteen. In addition to the plain belt drive design each size is built as a self-contained electric motor outfit, driven through pinion and internal gears, or by employing the short belt drive arrangement. The compressing end and electric motor of both gear and short belt drive units are furnished mounted on a common sub-base, so that they are in no way dependent upon the foundation for correct alignment.

Several noteworthy features of construction have been incorporated, of which the "constant-level" lubrication system is the most important. Others include the constant speed unloader for plain belt drive machines; the centrifugal unloader for start and stop control machines, and the increased size of the water reservoir cooling pot.

The lubrication of small vertical compressors employing the enclosed crank case and splash system has often been a source of concern wherever oil in the air is a serious menace. The tendency of the old system has been to feed too much resulting in discharged air containing excess oil, or too little causing scored cylinders, excess loads and burned out bearings.

The "constant-level" system used in type fifteen compressors automatically maintains a constant-level of oil, which insures the right amount being distributed to all parts.

As with the ordinary splash system, the base of the compressor forms an oil reservoir for the "constant-level" system. However, with this system, pet cocks determine the maximum and minimum amount of oil in the reservoir. Above this reservoir and directly underneath the connecting rod is a constant-level pan. Oil is pumped from the reservoir into this constant-level pan through a unique oil pump. Regardless of the amount of oil in the reservoir, so long as it is somewhere between the high and low level pet cocks, this system will function perfectly, insuring a constant-level of oil in the pan. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

The constant speed unloader controls

the unloading of the compressor by automatically opening the inlet valve when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus build up the receiver pressure again.

The centrifugal unloader allows the compressor to start under "no load" such as is essential when automatic start and stop control is used, and permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

The smallest size is built with either ribbed cylinder for air cooling, where the service is intermittent, or a water jacketed cylinder of the reservoir type for constant service. All other sizes are only built with the water jacket of the reservoir type. The size of these reservoir pots is very generous, and one filling will be found sufficient for long periods of operation.

A NEW TYPE OF MULTI-STAGE CENTRIFUGAL PUMP

Many engineers are not aware of the high efficiencies that can be obtained in centrifugal pumps by the use of a properly designed and proportioned volute rather than by the use of diffusion vanes.

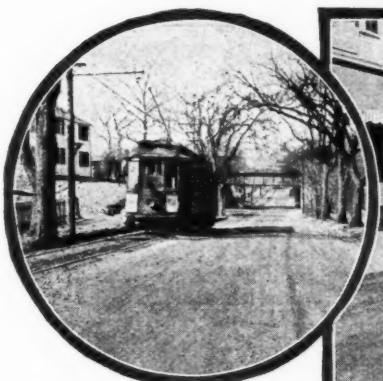
That the highest efficiencies are obtained with volute diffusors is best demonstrated by numerous official tests on volute type centrifugal pumps in water works service. For example, one installed at the municipal water works in Minneapolis has maintained the uniformly high efficiency of 86 per cent over a period of 4 years, during which time no replacements or repairs whatever have been made to the pump, while another at Toronto showed an efficiency of 87.2 per cent in a recent official acceptance test.

The Minneapolis and Toronto pumps are single-stage machines, but the enclosed article describes a multi-stage pump in which the advantages of the volute construction are retained, together with those of double suction impellers, including self-balancing and adaptability to high speeds.

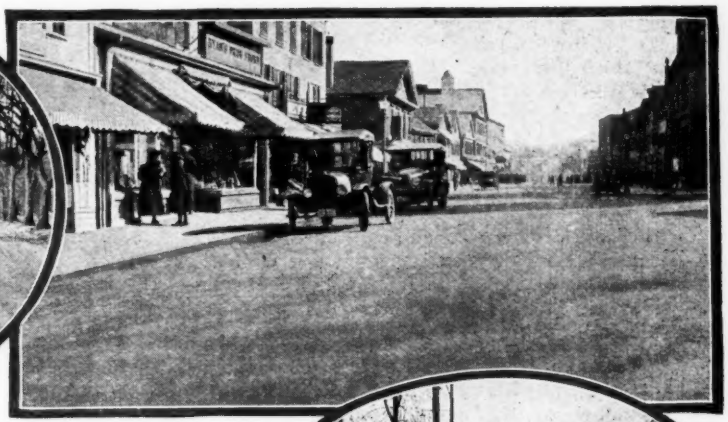
Where pumps driven by motors of slow or moderate speeds must deliver water at pressures higher than are desirable or practicable for a single-stage pump, instead of using a single-suction multi-stage pump, two separate single-stage pumps are sometimes connected in series, so that one discharges into the suction of the other. This method has frequently been adopted, particularly in water works service. In medium and smaller sizes the use of two independent pumps in series becomes somewhat more cumbersome, and a multi-stage pump is more often used. The length of shaft permissible in a multi-stage pump is limited because of the critical speed, and if many stages are employed the designer no longer has a free hand in providing water passages of the shape and size conducive to the highest efficiency. Consequently, where more than three stages are required, the single suction impeller which occupies less space on the shaft than does the double suction impeller, and thus permits the use of a shorter shaft, is used.

However, it is not possible to obtain as high efficiencies with a commercial multi-stage single suction pump as would be possible in a single-stage pump with double suction impellers, not only because of the less favorable limitations imposed on the impeller, but also because there is not sufficient space for an efficient volute diffusor and suitable return passages leading from the diffusor to the eye of the succeeding impeller. The De Laval Steam Turbine Co. therefore developed a new type of multi-stage pump, known as a "series" pump, in which the advantages of the double suction impeller are retained. This is made possible by the use of a specially formed casing, which provides individual volutes for each impeller, with ample interconnecting passages within the casing itself.

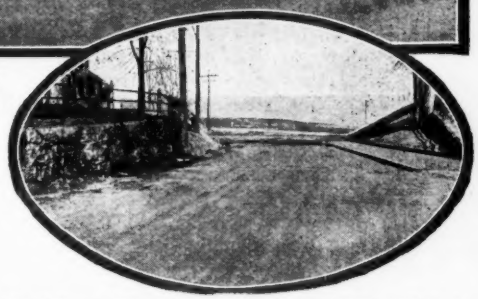
The double suction impeller gives perfect hydraulic balance, and two of the stuffing boxes, which would be required if two separate casings were employed, are eliminated, together with their friction. As compared with a single suction impeller, the double suction impeller has a smaller suction eye, which permits of making the impeller itself smaller in diameter, and hence the pump can be built to operate at a higher speed for a given head and capacity, or for the same speed, head and capacity, a higher efficiency is obtained. Besides giving the highest efficiency, the volute type diffusor is superior to diffusion vanes, in that it is not subject to clogging or rapid wear, and it also gives a broader efficiency



Court Street: The original "Tarvia-X" street built in 1909 and still a credit to the town.



Civic Center: An Example of "Tarvia-X" construction and maintenance, originally built in 1910.



North Street: Familiar to all the pilgrims to Plymouth Rock as a Tarvia street for the last 13 years. In addition to pleasure traffic it has taken the teaming from Plymouth wharves.

Tarvia in Plymouth, Mass.

THIRTEEN years is a short period in the history of Old Plymouth. But it is a long time for inexpensive pavement to withstand modern traffic, with next to no maintenance.

Mr. Arthur E. Blackmer, Superintendent of Public Works, writes:

"Our experience with Tarvia covers a period of consistent use for thirteen years—the town now has thirteen miles of Tarvia macadam.

"At the recent tercentenary celebration, held in the summer of 1921, over a million strangers visited this historic town, and Tarvia again proved its worth by satisfactorily protecting the roads, even though subjected to the consequent unusual traffic."

Plymouth has found through long experience that Tarvia construction insures maximum mileage of well-paved streets—that its moderate first cost permits a more extensive paving program, and its economical maintenance materially reduces the annual upkeep expense.

Not only in Plymouth, but in countless other cities and towns throughout the country, Tarvia is saving money for the taxpayers and providing better streets for all kinds of traffic.

Illustrated booklets of the various Tarvia treatments free upon request.

Tarvia

For Road Construction Repair and Maintenance

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York, Detroit, Pittsburgh, Youngstown, Baltimore, Chicago, New Orleans, Atlanta, Toledo, Omaha, Philadelphia, Birmingham, Duluth, Columbus, Jacksonville, Boston, Kansas City, Milwaukee, Richmond, Houston, The Barrett Company, St. Louis, Minneapolis, Bangor, Latrobe, Denver, Cleveland, Dallas, Washington, Bethlehem, Cincinnati, Syracuse, Johnstown, Elizabeth, Pittsburgh, Salt Lake City, Lebanon, Buffalo

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

curve, that is, a higher average efficiency over a wide range of delivery.

The pump casing is made in two parts, divided on a horizontal plane passing through the center line of the shaft, the suction and discharge openings being in the lower part, so that they are not disturbed when the casing cover is lifted. Perfect form and smoothness in the suction and discharge chambers and the passages connecting the volute of one stage to the suction chamber of the succeeding stage is secured by the use of dry sand molds in casting the casing and cover.

Leakage from the discharge chamber of each impeller back to the suction chamber of the same impeller is prevented by the use of labyrinth wearing rings. One ring of each pair, known as the case protecting ring, is held in a recess formed in the casing and the casing cover. The other ring, known as the impeller protecting ring, is screwed onto the impeller. The intermeshing grooves of the labyrinth rings present a long and tortuous path to water leaking from the discharge to the suction chamber, thus greatly reducing leakage, while at the same time permitting the use of amply large running clearances. One proof of the effectivenes of this device in preveting leakage is the much longer life of such rings as compared with ordinary flat wearing rings.

To prevent leakage from the suction chamber of one impeller to the suction chamber of the succeeding impeller, that is, from stage to stage, the bushings, where the shaft passes through the partitions between stages, are made of ample length. The shaft is protected between the impellers and from the impellers to the outer ends of the stuffing boxes by bronze sleeves, and the pump case and cover by bushings at the partitions. Sufficient clearance is provided so that the shaft sleeve and the pump casing bushing are not in metallic contact.

The efficiency curve of the series design is remarkably flat, that is, a high efficiency is maintained over a wide range of delivery. This is obviously a great advantage, and distinguishes this type of pump from pumps in which diffusion vanes instead of volutes are used for converting the velocity of the water leaving the impeller into pressure head. In other words, the advantage in this respect of the single-stage volute pump is now extended to multi-stage pumps of two and three stages.

DETERMINATION OF BRIDGE FOUNDATIONS BY WASH BORING

In the examination of bridge sites throughout North Carolina the Bridge Department of the State Highway Commission has used the wash boring outfit with success and the following description of it by P. K. Schuyler appeared in the North Carolina Highway Bulletin recently.

The apparatus was designed by H. C. Scott, construction engineer, and was built at the "Truck Patch" of the Commission. It consists of a 2-in. casing pipe which is driven into the ground by a 120 lb. hammer pulled up by hand in a set of 16 ft. leads and allowed to drop. Inside of this casing pipe is a wash pipe ¾-in. in diameter through which water is forced under 30 lbs. pressure by a 2 H. P. gasoline engine. The material is washed up between this pipe and the casing and is caught in a bucket or some vessel for examination. The outfit is transported from place to place in a "G.M.C." Light Aviation truck, rigged up especially for this purpose. Practically all of the material used in the construction of the outfit was obtained from surplus war material allotted to the State from the Federal Government thus making the construction cost practically nothing. The truck in which it is transported was also allotted to the State from surplus war supplies. The total cost of operation, including all overhead expenses, runs about 75c per lineal foot of boring up to 50 ft. which is the greatest depth that the machine is capable of boring. The force required to run the outfit consists of an engineer in charge, a truck driver, who also operates the pumping engine, and two laborers who are obtained locally. One boring requires about one day, much of the time being consumed in unloading and making the set up.

The saving to the State by the use of this outfit has been considerable since the results obtained often bring about a change in the contemplated design and further enables the contractor bidding on the work to know just what conditions he will encounter thereby making it possible for him to submit a lower initial bid.

Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—State Hwy. Dept. 1st contr. for grading and surfacing with gravel and 2½-in. penetration macadam 7.648 mi. Huntsville-Guntersville Rd. Madison Co., to Williams Bros. Constr. Co. and M. W. London & Son Roanoke, Va., at $124,057; grading & surfacing with 1½-in. penetrating macadam 6.87 mi. Decatur-Moulton Rd., Lawrence Co., to Stanley & Singer Constr. Co., Lafayette, at $181,917.

Ariz., Phoenix—Following contracts let by State Hwy. Dept.: Lee-Moor Contracting Co., El Paso, Tex., contract for 6.1536 mi. ,impvt. of Geronimo-Solomonvile Hwy., Fed. Proj. 43, at grand total of $171,602 (State furnishing materials); S. B. Shumway, Mesa, Ariz., contract for Sec. A, Prescott-Ash Fork Hwy., at $19,858.

Cal., Fullerton—Los Angeles Paving Co., 2900 Santa Fe Ave., Los Angeles, awarded contract for surfacing various streets with 3-in. Warrenite-bitulithic, at $10,000.

Cal., Long Beach—S. M. Kerns, 1034 Vina St., awarded contract to 33c sq. ft. for paving Cherry Ave. with 6-in. conc., about 173,781 sq. ft.

Cal., Sacramento—P. L. Burr, 823 Sheldon Bldg., San Francisco, awarded contract for grading and 5-in. gravel surfacing 13.5 mi. hwy. betw. Sneath Rd. and Half Moon Bay Rd., Div. 4, Route 55, Sects. A and B, San Mateo Co., at $336,814.

Colo., Denver—State Hwy. Dept. let contracts as fololws: Grading 1.453 mi. no. of Dillon toward Kremmling, F. A. P. 190, Summitt Co. 100 ft. steel truss brdg. over Blue River to Colo. Bridge & Constr. Co., Gas and Elec. Bldg., Denver, at $36,504; conc. paving 1.519 mi. Boulder Co., F. A. P. 222B, to Miller, Douglas & Hainer, 100 S. York St., Denver, at $56,885; gravel surfacing, 5.375 mi., Santa Fe Trail, Grenada St., line, F. A. P. 219A, 18 ft., Powers Co., to W. A. Colt & Son, Las Animas, at $52,607; 83 ft. conc. gird. brdg. over St. Charles River on Rye Rd. to Walsenburg with gravel approaches, F. A. P. 173, Pueblo, to J. R. Donaghew, Colorado Springs, at $24,650; grading 10.731 mi. rd. no. of Plattesville, F. A. P. 226-C, Weld Co. 16 ft. to C. R. Conover & Bro., 305 Bank Bldg., Denver, at $32,997; 7.474 mi. rd. F. A. P. 119B, to Girardet & Hotchkiss, Delta, at $44,654.

Kans., Iola—Fry Bros. Contg. Co., Iola, awarded contract for one course conc. 7.05 mi., F. A. P. 127, Sects. A and B, 75,000 sq. yds. conc., at $195,813.

Ky., Frankfort—State Hwy. Dept. let contracts as follows: Paving 12.775 mi. Barbourville-Pineville Rd. 14 ft. F. A. P. 39, Sec. A, rock asph. on conc., Knox & Kell Cos. to Metzel-O'Hearn & Lewen, Covington, at $338,398; 5.075 mi. Dixie Hwy., rein. conc. using vit. pipe, Boone Co., to Billiter & Oliver Bros., Covington, at $158,462; 13.92 mi. Camp Knox-Elizabethtown Rd. 16 ft. F. A. P. 79, bitum. macad. penetration, conc. pipe, Hardin Co., to R. B. Tyler, 114 S. 4th Street, Louisville, at $295,929; grading 9.717 mi. rd. from Morehead to Grayson, 24 to 28 ft. F. A. P. 68, cement rubble masonry, Carter Co., Hatfie'd Constr. Co., Huntington, W. Va., at $111,526; 8.103 mi. Stanton-Campton Rd., 24-28 ft. F. A. P. 71, using conc. pipe, Powell Co., to Codell-Byars, Winchester, at $153,-787; 10,207 mi. Stanton-Campton Rd. 24-28 ft. F. A. P. 72, cement trubble headwalls and conc. pipe, Wolfe Co., to Vermillion Contg. Co., Barboursville, at $81,686; 2,087 mi. Hazard-Whitesburg Rd. 24-28 ft. F. A. P. 81, using conc. pipe, in Perry Co., to Codell-Byars, Winchester, at $87,061; 5.422 mi. Greensburg-Hodgenville Rd. 24-28 ft. St. Proj. 41, rein. conc. pipe, Green Co., to Ping Bros., Somerset, at $49,683; gravel surfacing, 2.891 mi. Cadiz-Hopkinsville Rd. 18 ft. F. A. P. 73, using bank gravel, Trigg Co., to Alexander Bros., Cadiz, at $36,063.

Fla., Dade City—Finley-Method Co., Graham Bldg., Jacksonville, awarded contract for grading and paving with asph. on 8-in. rock road 2, at $214,211; Rd. 3, at $90,402; grading and paving on sand-clay base rds 4 & 5, at $25,538; Rds. 6 & 7, $33,720; Rd. 8, $34,310; Rds. 9, 10 and 11, $74,488.

Ga., Atlanta—Following contracts let by State Hwy. Dept.: 8.738 mi. rd. on Atlanta-Newman Hwy., from Fairburn to Campbell-Coweta Co. line; 92,470 sq. yds. 6-in. by 18 ft. rein. conc. pavement, F. A. P. 174, Secs. C & D, to Davis Constr. Co., Macon, Ga., at $230,000; 9 mi. rd. on N. C. line to Blairsville Hwy. from Blue Ridge to Blairsville; grade and gravel surf. to H. H. Gardiner, Columbus, Ga., at $100,000.

Ia., Holstein—Western Asph. Paving Co., Sioux City, awarded contr. for paving and curbing various streets, 106,400 sq. yds. conc., 48,296 ft. curb and gutter, 7,082 ft. 7-in. curb, at $299,335.

Minn., Grand Marais—Campbell-Ames Co., 402 Manhattan Bldg., Duluth, awarded contract for grading and bridging 14 mi. State Proj. 1.05, F. A. P. 298, 24 ft., at $162,000.

Miss., Pascagoula—S. A. Gano, New Orleans, awarded contract for construction of 8.44 miles 18 ft. conc. hwy. from Pascagoula to Ala. State line, at $269,588.

Miss., Yazoo City—Lobby & Williams Engrg. Service, Inc., Yazoo City, awarded contract for paving 3.92 miles road, 1:2:3 mix. conc., 16 ft. including 172 ft. and two 99 ft. rein. conc. bridges, at $140,742.

Mo., St. Charles—State Hwy. Dept. let contract to Moreno-Burkham Co., St. Louis, at $670,000 for 3.166 mi. rd., Warrensburg to St. Charles; 2.637 mi. St. rd., Warrenton to St. Charles; 4.920 mi. same rd., 3.74 mi. and 3.783 mi. all Warrenton to St. Charles, Sections 66, 67, 70, 72 and 73.

Mo., Jefferson City—Contracts for constr. of 18 miles St. Louis to Kans. City Hwy., St. Charles Co., approved by St. Hwy. Comn., at $670,000. Moreno-Burkham Constr. Co., St. Louis, has contract and will begin work on project immediately.

Mo., Jefferson City—State Hwy. Dept. let following contracts: Clay Co., 10.60 mi. State Rd., Kans. City to Liberty, one course conc. pavement, F. A. P. 990, to American Paving Co., Omaha, Neb., at $315,195; Daviess Co. 12.320 mi. state rd. St. Aid Proj. 20,206, to Capitol Constr. Co., Des Moines, Ia., at $38,538, for grading and constructing draing. structs.

Mo., St. Louis—Webb-Kunze Constr. Co., 5927 Fyler Ave., awarded contract by Board Pub. Service, for impvt. of 5,080 ft. Watson Rd., 18 ft. rein. conc., at $137,744; McKelvey Constr. Co., 911 Title Guaranty Bldg., awarded contract for 25,000 ft. Penn., Wise and other streets, Westmoor subdiv. in Richmond Heights, 15,000 lin. ft. conc. curb and gutter, 75,000 sq. ft. 4-in. walk, 40,000 sq. yds. asph. mac, 1,000 ft. 63-in. segmental and 24,000 ft. 8-24-in. vit. clay sewer pipe, at about $200,000; also contract for impvt. of 3,600 ft. Parkwood Subdiv. Morganford and Loughborough Aves., 26 ft., 30,000 sq. ft. 4-in. walk, 31,000 c. y. earth excav., 80,000 sq. ft. waterbound macadam, 1,200 ft. 8-36-in. vit. sewer pipe, at about $33,730.

Mont., Great Falls—Following contracts let for road work in Cascade County: 1—F. A. P. 73, Belt-Riceville, 10.64 mi., grade to White, Brown & Leahy, Gt. Falls, at $93,753; brdgs. to McGuire & Blakeslee, Gt. Falls, at $24,936. 2—F. A. P. 72, removg. brdg. across Belt Crk. Belt Twp. and constructing new brdg. to McGuire & Blakeslee, at $22,435.

Mont., Helena—White, Brown & Leahy, Ford Bldg., Great Falls, awarded contract for grading, gravel surfacing, also bldg. structs. on 10.64 miles Belt-Riceville Rd., F. A. P. 73, Cascade Co., at $109,729.

Mont., Misoula—Siems-Carlson, Spokane, awarded contract for Belton-Nyack section of Belton-Java Rd., 6.82 miles, at $180,000.

N. J., Perth Amboy—Graham & McKeon, 319 Oak St., awarded contract for exten. to Route 4, Sec. 19, Amboy Ave., at $118,217.

N. Y., Brooklyn—Following contracts let for grading, flagging and curbing: E. 37th St. to F. Persicano, 350 Fulton St., N. York, at $1,550; T. B. Scott, 671 Halsey St., 82nd Street, at $1,650; repaving Nassau Ave. Navy & Wallabout Sts., to C. Gallagher, 745 Dean St., at $40,053; $8,071 and $34,-164, respectively; 23rd St., to J. O'Hara, 557 3rd St., at $21,022.

N. C., Lexington—Harlee-Thrash Constr. Co., Florence, S. C., award. contract for 100,000 yds. asph. road betw. Lexington and Salisbury, at $150,000.

N. C., Raleigh—Lampton & Burks, Louisville, Ky., awarded contract by State Hwy. Comn., for 7.88 miles grading bet. Pollston and Wadesboro, Amson Co., at abt. $249,000.

N. C., Raleigh—Union Paving Co., Chicago, Ill., awarded contract for 220-282, Wayne-Duplin Cos., 28.75 mi. hard surf. rd. from Goldsboro to Warsaw, Route 40, at $708,011.90.

Ore., Salem—J. Hampshire, Ashland, awarded contract by St. Hwy. Department for grading 12.12 mi. Hayden Crk.-Kenosec, Ashland-Klamath Falls Hwy., Klamath Co.; surfacing Keene Crk.-Hayden Crk. sec. Ashland-Klamath Falls Hwy., Unit 1, 12.32 mi. Jackson Co., 24,000 cu. yds. broken stone, etc., to S. S. Shell Ashland, at $72,210; unit 2, 9.83 mi. Klamath Co., 19,000 cu. yds. broken stone, etc., to W. C. Stone, 654 E. Adler St., Portland, at $65,110; grading 9.35 mi. & surfacing 15.65 mi. Madras-Wasco Co. line, sec., the Dallas-Calif. Hwy., Jefferson Co., to Moore & Anderson, Heppner, at $81,843; 6 mi. grading Alsea Mtn. sect., Alsea Hwy., Benton Co., 43,000 sq. yds. com., 93,000 c. y. intermediate and 110,000 c. y. solid rock excav., at Joplin & Ekdin, Portland.

Okla., Madill—M. R. Amerman, 248 N. Market St., Wichita, Kans., awarded contract for paving, curbing and guttering 110 blocks, 110,000 sq. yds. rock asph., at $224,829.

Pa., Philadelphia—Barber Asphalt Paving Co., Land Title Bldg., award. contract for asph. and granite block pavement on Lancaster Ave., at $33,-568; asph. paving on Clearfield & Diamond Sts., Anderson, Etting and Sansom Sts., to Eastern Paving Co., Colonial Tr. Bldg., at $24,524 and $28,045, respect.; grading Algar St., to J. McCool, 124 Albanus St., at $31,151.

S. C., Greenville—J. T. Blassingame, Greenville, awarded contract for 15¼ miles State rd., Route 21, Cleveland to N. C. line, via Caesar's Head; 6¼ mi. claybound macadam; 9 mi. topsoil, at $178,000.

Tenn., Athens—P. M. Calloway & Co., awarded contract for street paving at $100,000.

Tenn., Johnson City—Municipal Paving & Constr. Co., Bristol, Tenn., awarded contract for 37,000 sq. yds. paving and 33,000 lin. ft. curb and gutter, covering 11 paving districts, at $100,000.

Tenn., Nashville—State Hwy. Dept. let contracts for following: 10.75 mi. road betw. Wilson Co. line and Carthage, Smith Co., F. A. P. 68, to Phillips, Simpson & McGugin Contg. Co., Stahlman Bldg., Nashville, at $161,849, for roadway, and $61,929 for bridges; 8.01 miles road betw. Tiptonville road and 5 miles west of Hornbeak, Lake and Obion Cos., F. A. P. 71, to J. Gray Constr. Co., Martin, Tenn., at $80,971.

Tenn., Newport—J. L. Humbard Co., Knoxville, Tenn., awarded contr. for 9.80 miles 8-in. limestone base road from Newport to N. C. state line, at $228,057.

Tex., Ballinger—J. B. Toomey, Ft. Worth, awarded contract for 10 blks. vit. brk. pavement, at $110,097.

Tex., Houston—Smith Bros., Sumpter Bldg., Dallas, awarded contr. for paving La Branch St., Texas to Holman Aves., at $126,943.

Tex., Lufkin—J. S. Moore & Sons, Lufkin, awarded contr. for grading, gravel surfacing, bitum. topping and bridging 9.72 miles St. Hwy. 7, Sec. A, F. A. P. 277, 16ft., at $170,317.

Tex., Pearsall—Uvalde Rock Asphalt Co., Cline, Tex., awarded contract for 17.8 miles State Hwy. 2; 49,460 cu. yds. gravel base, at about $300,000.

Utah, Salt Lake City—O. Nelson, Arimo Bldg., Logan, awarded contr. by State Rd. Comn., for grading and gravel surfacing 6.962 miles Sardine Canyon, 18 ft. F. A. P. 33, Boxelder Co., at $104,-194; Moran Paving Co., Felt Bldg., Salt Lake City, contract for grading and hard surfacing 6.413 miles rd. from canal no. of Magna to Tooele Co. line, 18 ft. F. A. P. 39, Salt Lake Co., at $187,086.

Va., Richmond—Pardoe & Gillespie Co., Fairfax, awarded contract by State Hwy. Dept., Richmond, for constr. of 5½ miles Proj. 168, Route 6, 16 ft. bitum. macadam, at $134,877.

W. Va., Charleston—Smith & Quynn, Parkersburg, awarded contract by St. Hwy. Dept. for gravel surfacing 1.9 mi. Grape Island Raven Rock Rd. Proj. 58, Pleasants Co., 16 ft., at $21,900; grading and paving with rock asph., 2.7 Welch-Coalwood Rd. Proj. 3.153, McDowell Co., 16 ft. to Rogers & Shumway, Worthington, at $134,965.

W. Va., Charleston—State Road Comn. let contracts for grading and draining following: Berkeley Co., 4.24 mi. Martinsburg-Hedgesville Rd., waterbound mac., to Bester-Long Co., Hagerstown, Md., at $89,974; Boone Co. 4 mi. Ramage-Madison Rd., to Herling Constr Co., Akron, O., at $50,124; Boone Co. 1.7 mi. Racine-Peytona Rd., to Nash, Cain & Turmin, Huntington, W. Va., at $30,808; Calhoun Co. 11 mi. Grantsville-Arnoldsburg rd., to Hardman & McKown, Spencer, W. Va., at $169,586; Clay Co. 4.6 mi. Mayser-King rd., to W. C. Markle, Clay, W. Va., at $64,581; Gilmer Co. 10 mi. Glenville-Normantown rd., to Kelley Cons. Co., Clarksburg, W. Va., at $225,568; Grant Co. 2.4 mi. Petersburg-Hardy Co. line, waterbound macadam, to J. L. Chandler, Virgilina, Va., at $57,212; Hampshire Co., 8.6 mi. Juncton to Hardy Co. line, to J. L. Chandler, Virgilina, Va., at $100,632; Mason Co. 5.5 mi. Henderson-Couch rd., gravel surfacing, to Coleman Bros., Ashton, W. Va., at $84,964; Mason Co., 9 miles Point Pleasant-Clifton rd., gravel surfacing, to Jas. E. Doyle, Huntington, W. Va., at $93,840; Mercer Co. 6 miles Simmons-Freeman Rd., waterbound mac., to Jno. E. Dougher & Sons, Union, W. Va., at $19,081; Mineral Co., 7.6 mi. Ridgeley-Alaska, gravel surfacing, to J. L. Chandler, Virgilina, Va., at $65,110; Nicholas Co., 5.7 mi. Summerville-Gilboa rd. to Lookout Constr. Co., Victor, W. Va., at $61,265; Pocahontas Co., 4.23 mi. Buckeye-Millpoint Rd., to Frank Echols, Marlinton, W. Va., at $38,983; Raleigh Co., 4.2 mi. Shady Springs Flat Top rd., bitum. macadam, to John E. Dougher & Sons, Union, W. Va., at $147,-842; Raleigh & Wyoming Cos., 4.17 mi. Iroquois-Amigo Rds., to F. H. Franklin & Co., Pocahontas, Va., $83,548; Summers Co., 4. mi. from end of rd. to Raleigh Co. line to P. M. Price, Hinton, W. Va., at $52,080; Upshur Co. 6 mi. Buckhannon-Randolph Rd., to W. H. Rhodes, Elkins, W. Va., at $63,811; Webster Co., 11 miles Point Mountain-Randolph Co. line rd., to Mace Constr. Co., Webster Sprgs., W. Va., at $90,645; Wayne Co. 3.63 mi. Echo-Fleming rd., to Hartfield Constr. Co., Huntington, W. Va., at $151,800; Wirt Co. 12 mi. Elizabeth-Spencer rd., to Ebersbach Constr. Co., Pomeroy, O., at $234,788.

SEWERAGE AND SEWAGE TREATMENT

B. C., Point Grey—Harrison & Lamond, 501 Pacific Bldg., Vancouver, awarded general contract for constr. of sewer at $23,201.

Ont., Hamilton—Central Foundation Co., Ltd., 14 Wellington St., awarded contract (general) for constr. of storm and san. sewer, at $84,994, on Kenilworth Ave.

Que., Hull—Laflamme & Laflamme, 40 Langevin St., awarded contr. for bldg. sewers in various streets, at $42,695.

Cal., Los Angeles—M. Simunovich W. 2705 66th St., Hyde Park, award. con. for constr. of storm drain in 17th Dr., West Blvd. to Rimpau Blvd., at $6,959; Peter S. Tomich, 425 N. Fremont Ave., contr. for constructing sewer in Wedgewood Pl. and in parts of other streets, at $17,500; M. Simonuovich, 2705 W. 66th St., Hyde Park, awarded contract for constr. of sewer in Commonwealth Ave., at $977.

Cal., Madera—L. R. Adell, Madera, awarded contract for constr. of sewage disposal plant, at $32,-292.

Cal., Santa Ana—Joe Chutuk, 343 Wilcox Bldg., Los Angeles, awarded contract for constr. of 22,100 ft. segmental blk. sewer 42-in. diam. and 18 in. manholes, Sec. A, joint outfall sewer proj. of Santa Ana, Anaheim, Fullerton and Orange cities, at $138,852.

Colo., Denver—Dennis Gibbons & Son, 1059 Downing St., awarded contract for 36,040 ft. 8-10 in. vit. pipe and 132 manholes in Berkeley Special San. Sewer Dist., at $35,417.

Ia., Cascade—W. B. Carter, 606 United Bank Bldg., Sioux City, awarded contract for 32,000 ft. sewers and disp. plant, at $46,543 and $24,046, respectively.

Mich., Detroit—J. A. Mercier, 216 Hammond Bldg., awarded contract for Southern Avenue arm of Lonyo Rd. sewer, and Lawton Ave. arm of Morrell St. sewer, at $33,723 and $34,941, respectively.

Mich., Detroit—T. W. Blanck & Co., 823 Ford Bldg., lateral sewer 3,686, $7,370, lat. 3,738, $5,302; lat. 2,741, $2,500; lat. 3,743, $3,135; lat. 3,744, $5,570; lat. 3,747, $3,654; lat. 3,751, $4,354; A. Rossi, 5307 Penn. Ave., lat. 3,739, $2,760; lat. 3,748, $600; J. Monti, 148 St. Joseph St., lat. 3,742, $7,125; G. Ponterelli, Wolverine Hotel, lat. 3,745, $7,953; Western Constr. Co., 1208 Ford Bldg., lat. 3,746, $932; Coolsaet Bros., 400 Penobscot Bldg., lat. 3,752, $9,800.

Mich., Springwe'ls—Contract for Sec. 16, Barclay Ave. sewer to R. A. Mercier, 5435 Wesson Ave., Detroit, at $145,000; Sec. 17, Maple Rd. sewer, Sec. 18, Dix Ave. Sewer, and Sec. 19, Eagle and Ford Ave. sewers, to Liberty Constr. Co., 1026 Book Bldg., Detroit, at $8,359, $19,637 and $9,956, respectively.

Minn., Waseca—Disp. contract let to Ward & Weighton, 510 Davidson Bldg., Sioux City, Ia., at $19,720; out. sewer, Reintertson & Patterson, Springfield, Mo., at $68,438; storm sewer, Rafdal & Curtis, Medford, Minn., at $11,777.

Mo., Maplewood—A. Lewald, 5909 Ethel Ave., St. Louis, awarded contract for 28,318 ft. 8-36 in. vit. clay and 1,800 ft. 42-in. segmental blk. sewers, etc., at $169,689.

Mo., Odessa—Merkle Machinery So., 1735 Walnut St., Kans. City, Kans., awarded contract for 35,000 ft. 8-in. sewer plant, at $45,000.

N. Y., Buffalo—Contract for 27-in. tile sewer in Hewitt Ave. to Dark & Co., 654 Main St., at $8,783; 10-15 in. tile sewer in E. Hertel Ave., and 10-24 in. tile sewer in Lenox Ave., to J. M. Fahning, 460 Leroy Ave., at $4,283 and $2,418, respectively; 10-20 in. tile sewer in Parkridge Ave. and 10-15 in. tile sewer in Cornwall Ave., to L. Di Pasquale, Buffalo, at $5.315 and $5,803, respectively.

N. Y., Syracuse—Roberts Filter Mfg. Co., 6th and Columbia Sts., Darby, Pa., (slip ring) awarded contract for machy. and equipt. for sewage pumpg. sta. and grit chamber, at $76,100.

N. C., High Point—H. D. Perry, Bessemer, awarded contr. for laying 35,000 ft. sewer lines and 20,000 ft. water mains, at $34,000.

Ohio, Cleveland—Contract for 740 ft. 5 ft. and 700 ft. 4 ft. circ. brk. and 380 ft. 12-24 in. vit. tile sewer in Bessemer Ave., let to P. W. Graham, 1274 W. 108th St., at $46,679; 275 ft. 24-in. vit. tile sewer in Lake Shore Blvd., to Kassouff & Co., 3182 W. 25th St., at $4,168.

Ohio, Cleveland—Ohio Contg. Co., Elyria, awarded contract for sewers in Short, Crossview and Chestnut Rds., at $95,913; Brookpark Rd. to Enterprise Paving & Constr. Co., 8444 Broadway, at $58,-441.

Ohio, Hamilton—Central Foundation Co., 14 Wellington St., Toronto, awarded contract for storm sewer up to 36 in. in Kenilworth Ave., at $84,994.

Okla., Oklahoma City—James & Eads, Miami, awarded contract for Maywood storm sewers and san. main sewers, at $63,693.

Tex., Laredo—James Constr. Co., San Antonio, awarded contract for 15.666 ft. 12-24 in. stand. vit. pipe sewers and 33 manholes in 7th Ave., at $638,-430.

Tex., Lubbock—James Constr. Co., Southwestern Life Bldg., Dallas, awarded contract for 1,500,000 gal. (daily) Imhoff sprinkling filter disposal plant, 20 miles 6-10 in. vit. sewer and 10 mi. 6-8 in. cast iron water main, at $230,000.

Utah, Salt Lake City—J. O'Conner, Utah Savings Bldg., awarded contr. for 29,000 ft. 8-18 in. vit. sewers, at $84,340.

Utah, Salt Lake City—Griffith & Burnside, Kearns Bldg., awarded contract for sewers in Farmers Ward; 30,000 ft. 8-36 in. sanitary sewers, 18 flush tanks, at $126,674.

Wis., Ellsworth—Camden Constr. Co., care J. B. Camden, Benson, Minn., awarded contract for san. sewers in various sts., including 25,900 lin. ft. 8-12 in. pipe, at $30,732; 3 Imhoff tanks, etc., to W. L. Oltman and F. H. Johnson, Ellsworth, at $16,942.

Wis., St. Croix Falls—Bradley & Gerischer, St. Cloud, awarded contr. for san. and storm sewers, at $34,864.

WATER SUPPLY AND PURIFICATION

Ark., Conway—F. L. Scully, Conway, awarded contract for constr. of settling basin having an approx. capy. of one million gals. and 2 large filters. Contract price $1.35 per c. y. for rein. concrete.

Cal., Knights Landing—(Grafton, P. O.)—L. F. Youdall, Commercial Savings Bank Bldg., Stockton, awarded contract by Meek Est., for rein. conc. pumping plant, using Byron Jackson pumps and G. E. motors, in Recl. Dist. 730, at $22,429.

Colo., Glenwood Sprgs.—White & Johnson, Chamber of Com. Bldg., Denver, awarded contract for 4,100 ft. tunnel and 1,500 ft. conc. and metal flume and appurts. thereto for city water supply, at $70,000.

Ga., Atlanta—Burford, Hall & Smith, awarded contract by City Water Board for equipment at water works consisting of two 30,000,000 gal. pumps for river sta. at $67,500 each, and one 30,000,000 gal. pump at Hemphill Sta., at $37,250.

Iowa, Bedford—Cowan & Smith, 1733 Walnut St., Kans. City, Mo., awarded contract for 19,046 lin. ft. 4-in. Cl. B cast iron mains, 3.3 tons Cl. D spcls., 28 fire hydrants, etc.; labor to N. E. Stucker & Son, Lawrence, Kans.; total cost, $18,500.

Mich., Bay City—Bay City Stone Co., Bay City, awarded contract for superstruct. for filtration plant, at $167,000.

Mich., Negaunee—Henry Trevarrow, Negaunee, awarded contract for infiltration gallery, receiving well, suction line, appurts., etc., at $17,500.

Mo., Hamilton—C. H. Everett, Hutchinson, Kans., awarded contr. for completing new water works system, at $68,488.

Mo., Milan—J. J. Hoffman, Milan, awarded contract for purification plant and extension of mains, at $13,401 and $29,000, respectively.

Ohio, Cleveland—P. F. Connolly, Commonwealth Bldg., awarded contr. for 10,400 lin. ft. 60-in. steel pipe for Fairmount Water Proj., at $398,341.

Ohio, Parma Heights—D. Pfahl & Co., Guardian Bldg., Cleveland, award. contract for 22,622 ft. 12-in. mains, at $109,852.

Ohio, Wickliffe—D. H. Whittaker, 343 The Arcade, Cleveland, award. contract for mains in Worden Ave., at $16,713; J. B. Lynn, 343 The Arcade, Cleveland, contract for mains in Wade Ave., at $3,536. Work involves 7,300 ft. 4-8 in. cast iron pipe.

Okla., Tulsa—Tibbetts & Pleasant, Inc., awarded contract to construct Elm Park relief storm sewer, at $600,000.

N. Y., Elmsford—T. M. Hughes & Co., No. Tarrytown, awarded contr. for extending mains, at $56,-304.

N. Y., New York—Beaver Eng. & Contg. Co., 57 Chambers St., awarded contract for mains on subway bridge over Bronx River and on hwy. brdg. over N. Y., New Haven & Hartford R. R.; also on Westchester Ave. and Edgewater Rd., at $10,080.

Ohio, Cleveland Heights—(Warrensville, P. O.)—B. H. Whittaker, 335 The Arcade, Cleveland, awarded contract for water mains in Blanch, So. Compton and Hyde Park Rds., at $17,262.

Ore., Medford—Lindstrom & Ferguson, Portland, awarded contract for bldg. new City reservoir of

Tex., Dallas—Chicago Bridge & Iron Wks., Prae-2 million gals. capy., at $27,561.
torian Bldg., awarded contract for one million gal. reservoir, Sunset Heights, steel tank, conc. found., at $22,700, plus $2,690 for foundation.

Tex., Marlin—National Cast Iron & Foundry Co., Birmingham, Ala., awarded contract for 562 tons pipe to lay line from new standpipe to reservoir now under constr., at $28,662.

Tex., San Juan—Gulf Machinery Co., Galveston, Tex., awarded contract at $20,780 for water works plant, for constr. of 6-in. water main and tank with capy. of 60,000 gals.

Tex., Sherman—Texas Tong & Tool Co., Elmhouse, Tex., awarded contract for second well at Fairview pumpg. station, at $20,000.

Wash., Centralia—American Wood & Pipe Co. awarded contract by Bucoda City Council for constr. of town's new water system. Work will begin immediately. Plans call for two 60,000 gal. reservoirs. Est. cost about $25,000.

Wash., Tacoma—R. C. Polk (representative of American Cast Iron Pipe Co., of Birmingham, Ala.) Tacoma, for furnishing cast iron pipe to be used in constr. of the So. J and K streets trunk water main, at $46,119.

Prospective Work

ROADS AND STREETS

Ark., Fort Smith—City Comn. plans repaving 60,000 sq. yds. sts. Est. cost $125,000. Will soon consider bids. Contemplate bldg. road from Ft. Smith to Fayetteville on day labor basis without contract. Sebastian Co. will soon let contract for 18 miles shale rd. from Ft. Smith to Greenwood.

Govt. aid project. Est. cost from $70,000 to $80,000.

Cal., Coronada—City Manager Hyatt reports plans under way for paving streets in section of City known as the flats, comprising parts of 5th and 6th Sts., Margarita Ave., Miguel and other avenues. Est. cost $150,000.

Cal., Sacramento—Bids for constr. of coast blvd. betw. Huntington Beach and Newport, will be advertised about latter part of December. N. D. Darlington, St. Hwy. Commr. Co. Engr. J. L. McBride, Santa Ana, now securing rights-of-way, which will be 100 ft. to provide for future widening.

Cal., San Francisco—City and San Francisco County plan street impvt. costing $284,000. M. M. O'Shaughnessy, City Engr.

Cal., Santa Ana—Movement on foot to widen Whittier Blvd., Pasadena Ave., as far south as possible. Conc. roadway with curbs and walks, and possibly lights would be constructed. Petition with more than 50 per cent of prop. owners signed, presented to Co. Supvrs.

Fla., De Land—Volusia County Commrs., New Smyrna Special Rd. and Bridge Dist., plans impvt. of following: Sec. of Dixie Hwy. from Rose Bay to south county line; Rd. from Dixie Hwy. to Co. line toward Shiloh, Brevard Co.; from New Smyrna to St. John's River Ferry; road from Samsula toward De Land. Contemplates voting on $600,000 bonds.

Fla., Inverness—Citrus County having plans prepared for 75 miles of paved roads. Election will be called in near future to vote on plan. E. V. Camp & Associates, Moreland & De Kalb Aves., Atlanta, Ga., Engrs.

Fla., Pasadena—Gulf Beach Resort Co., A. B. Archibald, Pres., interested in bldg. causeway from foot of Centre Ave., across Boca Ceiga Bay to Treasure Island, connecting with present brick road to Pass-a-Grille; petition Co. Commrs. to issue $200,000 bonds.

Fla., Stark—Bradford County plans following: 12 miles Sanderson Rd., Stark to Redding brdg., $48,000; 7 mi. Lawtry-Raiford rd., $28,000; 7 mi. rd. from Brooker to Wynn Farm, via Graham, $28,000.

Fla., Tampa—Hillsborough Co. Commrs. will construct approx. 100 miles hard surf. rd. in connection with 2½ mi. sea wall and fill. Contemplate bond issue.

Fla., W. Palm Beach—City Commission—Karl Riddle, City Mgr.—plans expending $122,000 for street impvts. in Paving Dist. 3; penetration method or surf. treatment. Will soon invite bids.

Idaho, Boise—State Hwy. Commission making plans for grading and gravel surfacing 10.7 miles Idaho-Pacific Hwy. F. A. P. 65, from Georgetown to Caribou Co. line, 20 ft. Est. cost $95,000. D. P. Olson, Director of Highways.

Ill., Edwardsville—Madison Co. Rd. & Bridge Comn. will take bids about January 1st for paving 4,135.9 ft. Sec. 41-15d, 18 ft. roadway, 6 ft. earth shoulders, 8,300 sq. yds. Portland cement conc., $23,253 to $25,000. W. E. Howden, Edwardsville, Supt. of Hwys.

Iowa, Clinton—Resolution passed by Council for street impvts.; have authorized $109,866 bonds. F. W. Needham, City Clk.

Iowa, Wapello—Plans being made for conc. pavement—30 blks. Est. cost $200,000. A. E. Archer & Co., 312 New England Bldg., Kans. City, Mo., Engrs.

Ky., Bardwell—Carlisle County plans road impvts.; considering voting on $250,000 bonds.

Ky., Hopkinsville—State Hwy. Dept., Frankfort, has approved plans for bldg. 9 miles Gracel Rd.—Hopkinsville to Gracey—connecting with F. A. Rd. crossing Trigner Co. to Eggner's Ferry on Tenn. River. Est. cost $211,000. Christian County will pay $52,800.

La., Springville—Livingston Parish Police Jury plan shard surfacing 60 miles dirt road in Dist. 3—Springfield to Ponchatoula via Springville, Ft. Vinvent, French Settlement, Maurepas and Clio. $80,000 bonds voted.

La., Vermilion Parish—Vermilion Parish has just voted $2,500,000 for road bldg.—a $500,000 tax and bond issue to link up its capitol, Abbeville, with neighboring parish seats of Iberia, Lafayette and Acadia, besides providing for considerable mileage for lat. rds. in road dist. Dist. is composed of 5 different wards in parish represented at elect., giving a majority of 500 in number of votes and over $2,500,000 in value of assessment in favor of the tax.

Md., Baltimore—Dept. Pub. Impvts. plans bldg. 1 mile 120-ft. boulevard, connecting Govans with 33rd St. Blvd. east of Venable Stadium.

Md., Towson—Baltimore County contemplates improving roads. $2,000,000 bonds voted.

Mich., Kalamazoo—Kalamazoo Co Bd. of Supervisors voted to raise $99,912 for county roads and $146,335 for Covert Act Rds. Rds. recommended for constr. include following: 1½ mi. Oshtemo Twp., $12,000; 3 mi. on twn. line rd. bet. Schoolcraft & Brady Twps., $24,000; 1½ mi. Pavilion Twp., Pickeral Lake cors. west, $12,000; 1 mi. Alamo Twp., $8,000; 7 mi. trunk line rd. on S. Westedge Ave., Kalamazoo & Portage Twps., 1 mi. Alamo Twp., 1 mi. Schoolcraft Twp., 1 mi. Pavilion Twp., besides mile and a half recommended, 2 mi. Comstock Twp. and 1½ mi. Cooper Twp.

Mich., Lansing—State Hwy. Commr. F. F. Rogers has prepared tentative program for constr. of approx. 933 miles in 1923, to be divided as follows: 282.31 mi. pavement; 80.85 mi. macadam; 449.05 mi. gravel and 120.6 mi. grading and culvert work. Est. total cost $14,522,300.

Minn., Duluth—Paving program for 1923 includes: 2300 ft. Mich. St.—Lake to 5th Aves., W.; 1840 Fifth Ave., Superior St. to dock front; also 6 streets in Lakeside residential dist. Conc. or macadam. E. K. Coe, City Engr., 1114 E. Third St., Duluth. J. A. Farrell, Commr. Est. cost $1,000,000.

Miss., Charleston—Tallahatchie Co. plans bldg. 18 miles surf. hwy. between Charleston and Webb, connecting Charleston and Sumner; Delta Hwy. with Air Line Route of Jefferson Davis Hwy. $200,000 bonds voted.

Miss., Vicksburg—Mayor plans expending $130,000 for 40,000 sq. yds. street paving. J. J. Hayes, Mayor; F. M. Garvey, City Engr.

Neb., Omaha—Will probably call for bids in near future for resurfacing 24 paved streets. Est. cost $250,000. C. F. Bossie, City Clk.

N. J., Newark—$400,000 bonds voted by Essex County for parkway to connect Branch Brook Park with Bellvills Park.

N. Y., Rochester—City considering laying sidewalks and grading Meadowbrook Rd., Arbor Dr., Laney and Azalea Sts., $38,800; paving Santiago St. conc., $11,900; Lapham St., asph., $22,300; Marlboro Rd., asph., $11,800; Salina St., asph. blk., $12,200. C. A. Poole, City Engr.

N. C., Snow Hill—Town contemplates hard surfacing principal business and residential streets.

Ohio, Bedford—Suburban Land & Homes Co., care H. H. Hardesty, 1011 Swetland Bldg., Cleveland, having surveys made for grading, laying walks, mains and sewers at Stop 17, Bedford. $100,000. F. A. Pease Eng. Co., Marshall Bldg., Cleveland, Engrs.

Okla., Oklahoma City—State Hwy. Commission will soon let contract for hard surfacing about 100 miles Postal Hwy. bet. McAlester and Fort Smith; gravel, bitum. or conc. Approx. cost $2,500,000, half to be paid by state and half by Fed. Aid fund. B. E. Clark, State Commissioner of Hwys.

Ore., Astoria—$50,000 appropriated at recent meeting of taxpayers for purpose of paving main Nehalem Hwy. from end of present pavement at the Olney cutoff; Astoria Rd. Dist. appropriated $20,000 in addn. to the $18,000 already in fund, to pay for Williamsport rd. leading along short of Young's River from ft. of 7th St. in this city to connect with Nehalem Rd.

Ore., Portland—City Engr. Laurgaard will report to City Council on proposed widening of Sandy Blvd., in connection with widening of E. Burnside and E. Couch. Combination project, estimated to cost about $390,000.

Tex., Austin—State Hwy. Dept. Austin, has approved following plans: Surf. 11.55 miles State Hwy. 3, Medina Co., gravel and bitum. topping, $180,000; 10.75 mi. St. Hwy. 3, Medina Co., gravel bitum. rd., $158,000. R. J. Noonan, Co. Judge; Walton & Ameson, Co. Engrs., Gunter Bldg., San Antonio, Tex.

Tex., Beaumont—U. S. Bureau Pub. Rds., Washington, D. C., has approved plans for 17 miles 18-ft. conc. paved road on State Hwy. 3, Amelia to Liberty Co. line; Jefferson Co., F. A. P. 312, $558,604. J. B. Peak, Co. Judge. A. C. Love, Co. Engr.

Tex., Dallas—Plans being made for widening, paving and extending St. Paul St.—Commerce to

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Marilla Sts.—50 ft., $308,000. G. Fairtrace, City Engr. E. A. Ward, City Plan Engr. Dallas County having plans prepared and will take bids about Dec., for improving 12.6 mi. Richardson Rd., St. Hwy. 6, 18-20 ft., $500,000; take bids about January for grading and bitum. surfacing 5 miles Bonnie View Rd., 18 ft., $75,000; 13 miles Beckley Rd., 18 ft., $150,000; 4 mi. W. Dallas-W. Moreland Rd., 18 ft., $60,000. Nagle-Witt-Rollins, Court House, Engrs.

S. C., Winnsboro—Fairfield Co. will construct road connecting Cheer and Richland Cos.; $500,000 bonds voted.

Tex., Houston—Harris County contemplates voting on $890,000 bond issue for grading and conc. surfacing 17.8 mi. La Porte Rd.—Galveston Pike to La Porte, 18 ft. including bridges over Simms and Vina Bayou; $540,000 bond issue for 12 miles of road betw. Ureka and Cypress, 18 ft. Howe & Wise, 211 1st Nat'l Bank Bldg., Engrs. Harris County plans constr. of 12 miles 18 ft. conc. road on Washington Co. road betw. Eureka and Cypress. Est. cost $540,000. Howe & Wise, Engrs., 211 First National Bank Bldg.

Tex., Houston—Mayor plans expendt. of $1,500,000 for paving, including 2 new highways in Houston Heights from North Side and South End; Polk Ave. from business dist. thru Eastwood toward Harrisburg; Dumble St. connecting McKinney Ave. with Harrisburg Blvd.; Washington Ave., business district to Heights; Preston Ave. to Dowling St.; Dowling St., Preston Ave. to Holman. Plans graveling 32 streets. O. F. Holcombe, Mayor.

Tex., Jasper—Jasper County plans 11 miles 16-ft. gravel rd. on State Hwy. 8, Buna to Hardin Co. line, $163,000. C. B. Neel, Co. Judge; C. P. Hunter, Co. Engr.

Tex., Liberty—Liberty County, S. H. Cain, Judge, will build 36 miles of 18-ft. conc. paved rd. on St. Hwy. 36, Houston-Beaumont Rd. from Harris Co. line to Jefferson Co. line; State and Fed. Aid, including county bond issue. Total $300,000. W. C. Young, County Engr.

Tex., Paris—Lamar Co., W. L. Hutchinson, Co. Judge, plans following impvts.: Surf. 9.9 mi. St. Hwy. 19, no. of Paris, gravel, $63,500; surf. 9.24 mi. St. Hwy. 19, so. of Paris, sledged limestone rock base; gravel top, $75,200. W. M. Fooshee, Co. Engr.

Tex., Pittsburg—Chief Engr. U. S. Bureau Pub. Rds., Washington, D. C., approved plans for 16.66 miles 16-ft. gravel bitum. rd. on State Hwy. 1-A, Camp Co., F. A. P. 55. Est. cost $308,720. J. A. Elfried, Co. Judge. Chas. C. Chappell, Co. Engr. Bureau also approved plans for 10.43 mi. 16-ft. gravel bitum. rd. on State Hwy. 19, from Harris Co. line to Brazoria Co. line, Ft. Bend Co., F. A. P. 318. Est. cost $150,000. C. D. Myers, Co. Judge (Richmond), and C. H. Kendall, Co. Eng. (Richmond). Plans also approved for 3.75 miles State Hwy. 17-A, Reeves Co., F. A. P. 320, $22,865. J. F. Ross, Co. Judge, Pecos; A. D. Adcock, Co. Engr., Balmorhea, Tex.

Tex., San Antonio—Ch. Engr. U. S. Bureau Pub. Rds., Washington, D. C., has approved plans to surf. 8.38 miles St. Hwy. 2, macadam, Bexar Co., F. A. P. 264, $145,027. A. McCloskey, Co. Judge; R. E. Keeler, Co. Hwy. Engr. Bureau has also approved plans for impvt. of 7 mi. Chandler Rd., Smith Co., F. A. P. 316, $80,000. D. R. Pendleton, Co. Judge. D. K. Caldwell, Co. Engr.

Tex., Sequin—Chf. Engr. U. S. Bureau of Pub. Rds., Washington, D. C., has approved plans for 3.4 miles 15-ft. gravel bitum. road on St. Hwy. 3, $36,744. Hess & Skinner, Engrs., Southwestern Life Bldg., Dallas, Tex.

Tex., Sinton—San Patricio County will soon ask bids for surfacing 15.1 mi. San Antonio-Corpus Christi Rd., east branch of St. Hwy. 9, with 1-in. bitum. topping. Approx. cost $105,000. A. C. Pancoast, Co. Engr., Beeville, Texas.

Va., Petersburg—City plans expendt. of $150,000 to repave Sycamore St., Grove Ave. to Wythe St., and W. Washington St., Sycamore to city limits. L. Browlow, City Manager.

Wash., Seattle—Second Denny Hill regrade proj., involving removal of 3,500,000 c. y. earth west of Westlake Ave., bet. Virginia and Denny way, is under consideration. City Engr. J. E. Blackwell requested to prepare surveys and cost ests. of work. Should the work contemplated prove as costly as the pending Beacon Hill sluicing proj., the cost will be three to four million dollars.

Wisconsin—Taylor County Bd. appropriated $9,000 for rd. mchy. C. Keinhofer, Medford, Commr.; Co. Co. Bd., $212,174 for st. & co. aid rd. & brdg. constr. Henry Mink, Lancaster, Commr.; also $12,000 for rd. mchy, including 1 tractor, 2 trks, 1 12-in. blade grader, 10 patrol graders and 10 rd. drags; also $500 for mach. shop equip.; Jackson Co. Bd. $3,000 for rd. mchy., including 1 tractor, 12-in. grader and 2 patrol graders. Wm. Tibbits, Black River Falls, Commr. Oconto Co. Bd. made available for st. and co. aid rd. and brdg. constr. $61,000. E. W. McAllister, Oconto, Commr. Also appropriated $5 000 for rd. mchy. Milwaukee Co. Bd. approp. $509,848 for state and co. aid rd. and brdg. constr., also $10,000 for rd. mchy. W. F. Cavanaugh, Milwaukee, Commr. Pepin Co. Bd. appropriated $40,569 for state and county aid rd. and bridge constr.; also $3,500 for rd. machinery, including 10-ton tractor and large grader. Gale A. Goss, Durand, Commr. Fond du Lac Bd., $10,000 for various kinds of rd. mchy. Geo. Treleven, Fond du Lac, Commr. Jackson Co. Bd. made available for state and county aid rd. and brdg. constr., sum of $105,757. Wm. Tibbitts, Black River Falls, Commr. Marathon Co. appropriated $158,062 for state and co. road and bridge constr. in 1923; also $14,000 for purchase of rd. mchy., including one 12-in. and 6 patrol graders, one gravel crushed and screening plant. J. H. Vogt, Wausau, Commr. Clark County will have available for state and county aid road and bridge constr., $99,817 in 1923. Bd. has also appropriated $5,000 for purchase of road machinery, including graders. O. J. Wehmiller, Commr.

W. Va., Charleston—State Road Commission has tentative plans for following projects in Clarksburg Dist.: 9 miles from Cycamoredale to Jane Lew, connecting Clarksburg and Weston; Rd. from Bridgeport to end of paving west of Grafton, connecting Clarksburg and Taylor Co. seat; build gap bet. W. Union and Harrison Co. line; awards contingent upon passing of $15,000,000 or $20,000,000 bond issue.

W. Va., Weston—City will extend paving system and install sewerage system. Vote in December on $300,000 bonds. Half for paving and half for sewerage.

W. Va., Weston—Lewis Co. Commrs. Court, Freeman's Creek Dist., will construct 25 miles hard surf. roads as follows: Jackson's Hill to Freemansburg; Camden to Fink; Weston to Kincheloe brdg.; Alum brdg. to Fink; $800,000 bonds voted.

SEWERAGE AND SEWAGE TREATMENT

Cal., Lodi—City plans election to vote on issuance of $100,000 bonds for sewage disposal plant. C. F. Smith, 7 Nottingham St., Berkeley, Cal., Engr.

Cal., Pomona—City Engr. F. C. Froehde & Mayor T. R. Oveington have proposed a $100,000 bond issue to provide funds for constr. of new outfall sewer. Present sewer line is inadequate, one entire section of city being without sewerage. It is proposed to build a joint line with old one, suitable for city of 40,000. Sys. approved by St. Bd. of Health, provides for activated sludge plant on 100 acre farm owned by city.

Cal., Tracy—Election will be held to vote on $50,000 bonds for sewage disposal plant, Imhoff tank, etc. W. D. Harrington, City Engr.

Ont., Hamilton—Plans being prepared for intercepting sewerage system. E. R. Gray, City Engr. Est. cost $25,000.

Qubec, Hull—Council will construct sewers at cost of $100,500 and water works extensions at cost of $59,000. Work by Day Labor, Theo. Lanctot, Engr.

Ont., Ottawa—City will construct storm sewer at cost of $50,.000 on Harmer St. by Day Labor. A. F. Macallum, Commr. of Works.

Ont., Sandwich—Plans being prepared for sewage disposal plant. Est. cost $150,000. Prices desired on all materials. McCall & Patterson, Gas Bldg., Windsor, Cons. Engrs.

Colo., Denver—Plans and estimates being prepared for storm sewer in Park Hill storm sewer dist., $1,000,000. A. K. Vickery, City Hall, Engr.

Conn., Hartford—City planting exten. of interceptor sewerage sys. Est. cost $34,000. City Engrg. Dept., care Pub. Wks. Bd. Engrs.

Fla., Jacksonville—City will lay storm water pipes to drain abt. 40 acres in vicinity of 26th and Perry Sts. Est. cost $19,000; relay san. sewers on

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Myrtle Ave., bet. Enterprise and State St., $14,000; establish sewer outfall near end of Clay St., $6,655. W. E. Sheddan, City Engr.

Fla., St. Petersburg—City plans constr. of san. sewerage system, $90,000; replacing sewers, $40,000. C. C. Brown, Acting Director of Pub. Wks.

Ia., Muscatine—Plans made for draining so. part of city. Center State Engrg. Co. C. H. Young, Muscatine, $98,880.

Ia., New Vienna—Plans completed for sewer system and disposal plant. Will ask bids early in 1923. Howard R. Green Co., Cons. Engrs., Cedar Rapids.

Ia., North English—Town will advertise for bids in January for complete sewer system and disposal plant. H. R. Green Co., Cons. Engrs., Cedar Rapids.

Ia., Osslan—Howard R. Green Co., Cons. Engrs., Cedar Rapids, Ia., preparing plans and specfs. for complete sewer system with disposal plants. Bids will be asked late in January.

Ia., Washington—City will probably start work in February on trunk sewer and disposal plant. Cons Engrs. W. E. Buell & Co., 205 Grain Exch. Bldg., Sious City, Engrs. Est. cost $200,000.

Kans., Oakley—Plans being prepared for new sewerage system and disposal plant, $50,000. C. A. Haskins, 517 Finance Bldg., Kansas City, Mo., Engrs.

Mass., Fall River—City plans constr. of sewerage extension on N. Main St., no. of New St., $100,000. A. Wolstenholme, City Engrs.

Mich., Ferndale—City plans laying 10,000 ft. lateral sewers in Rockwell Ave. and other streets, including 3,000 ft. 10-in., 3,000 ft. 12-in. and 4,000 ft. 15-in. vit. or conc. pipe. Est. cost $40,000. G. Jerome, 1331 Majestic Bldg., Detroit, Engr.

Minn., Henning—Plans made for sewer system. Druar & Milinowski, 500 Globe Bldg., St. Paul, Cons. Engrs. Maturity indef. O. L. Scorheim, Vil. Clk. Est. cost about $60,000.

Minn., Rochester—Constr. of sewage disposal plant being considered. Est. cost $150,000. Jas. T. Spillane, Sewer Commr.

N. J., Elizabeth—Plans being made for sewer under Elizabeth River, at 3rd Ave., betw. Palmer and Garden Sts., $60,000. J. H. Fuertes, 140 Nassau St., New York City, Engr.

N. J., Roselle—City preparing plans for 12-24 in. tile and conc. sewers in vicinity of Pine St. and 9th Ave., $40,000. J. L. Bauer, 120 Broad St., Elizabeth, Engr.

N. J., South River—City plans 3,800 ft. trunk sewere in Hillside Ave. Est. cost $28,000. C. C. Armstrong, Soith River, Engr.

N. M., Santa Fe—Plans being completed for sewage plant. Est. cost $115,000. H. F. Gray, Santa Fe, Engr.

N. Y., Rochester—City plans constr. of sewage disposal plant in Hopper Hollow Sec., $50,000; sewers and walks in Crossman Terrace, $31,300. C. A. Poole, City Engr.

N. C., Saluda—Additional sewer constr. contemplated by city, $250,000 bonds.

Okla., Shattuck—Plans prepared for sewer laterals, $45,000. H. G. Olmsted & Co., 415 Oil Exchange Bldg., Okla. Ctiy, Engrs.

Pa., Ambridge—City plans sewage disposal plant on Ohio River, cost to exceed $25,000.

Pa., Butler—City Counlil authorized $300,000 bond issue for sewage disposal plant.

Pa., Harrisburg—$150,000 bonds voted for sewers. M. B. Cowden, City Engr.

Pa., Midland—City plans 1,860 ft. 48 in. san. sewer extension at cost of $40,000. J. P. Stone, Boro. Secy. Engineer not announced.

S. C., Clover—City will install sewerage system and water works; $65,000 bonds voted.

S. D., Watertown—Resolution passed for constructing sanitary sewer on various streets. B. Mather, City Aud.

S. D., Yankton—City will construct san. sewer in Spring; 10, 12, 15 and 18-inch pipe. Est. cost to state $18,000, to city $19,000. John W. Summers, City Clerk.

Tex., Harlingen—City has plans for sewer system. Will soon call for bids. Est. cost of disposal plant, $20,000; cost of sewer system, $52,000.

Tex., Tulia—$30,000 bonds voted here for sewer extension.

Wash., Hoquiam—Estimates being compiled by Chief Engr. W. L. Lovejoy for 3 sewerage districts. Ests. are for replacement of wood box sewers which have been in use for several years. Districts are as follows: All of city no. of Emerson St. and west of Lincoln; all east of Lincoln and no. of Eklund Ave.; all of city west of Ontario St. In last named district, west of 28th St., there are no sewers.

Wis., Marshfield—Plans being prepared for san. and storm sewers, including septic tank, $25,000. G. Leonard, Clerk. T. Pankow, Wash. Bldg., Madison, Engr.

WATER SUPPLY AND PURIFICATION.

Ala., Mobile—City contemplates extending water works system and improving fire department. Will vote on $400,000 bond issue.

Ont., Kingston—City considering bldg. filtr. plant. Est. cost $350,000. Howard Dick, Engr.

Ont., Hanover—$135,000 bonds voted for extension to water works system, including reservoir, 3 miles pipe line to Rhul Lake, etc. F. W. Thorold, 54 Admiral Rd., Toronto, Engr.

Ga., Atlanta—City will extend water pipe line on various sts. at cost of $150,000. Walter C. Taylor, Clerk.

Ga., Waynesboro—City will install water works and sewer system at cost of $100,000. J. B. McCrary, Engr., Atlanta.

Md., Williamsport—City will install water works system; $100,000 bonds voted.

Mo., St. Louis—Board of Estimates and Apportionment approved bond items, aggregating $88,372,,500. City will vote Feb. 9 on bond issues for following work: Water works, hospital, sewer system, electric light, playgrounds, new paving, impvt. of present paving system, grade crossing and viaducts, municipal heat, light and mechanical bldg., fire department equipment, civic bldg., city market, memorial plaza, sites for memorial and civic bldgs., etc. W. Frank Carter, Chrmn. on Civic Needs.

Mo., St. Louis—City contemplates purchase of coated cast iron pipe, special castings, valves, fire hydrants, valve boxes and other materials, $100,000. E. E. Wall, City Hall, Water Commr.

N. Y., Keeseville—Appropriation of $100,000 voted for village water supply.

N. C., Asheville—Plans of Carolina-Tennessee Power Co., which has its main offices in New York, for hydro-elec. power development on Hiawassee River in Cherokee county, nearing completion. Development will involve construction of 2 dams and 2 generating stations of sufficient capacity for producing 60,000 horsepower. Cost of proj. estimated at $5,000,000 to $7,000,000. Capital available. Preliminary surveys completed and specfs. for work nearly finished.

N. C., Elizabeth City—City will improve sewer system, water works and light system; $800,000 bonds voted. Wm. C. Olson, Kingston, Cons. Engrs.

N. C., Lincolnton—City will extend and improve water, sewer and electric light systems; $180,000 available.

N. C., Marshville—City will install water, sewer and electric systems; $140,000. J. B. McCrary Co., Engrs., Atlanta.

Okla., Woodward—Will vote on $175,000 bonds for construction of water system. City has plans; prepared by Black & Veatch, Cons. Engrs., Kansas City, Mo.

Ore., Portland—City considering construction of Bull Run pipe line, 10 miles 60-in. and 14 miles 52-in. riveted steel pipe, or 10 miles 58-in. and 14 miles 50-in. lock bar pipe, clearg. and grubbg. 16 acres three 80-ft. comb. hwy. and pipe spans with abutments, $1,000,000. F. Randlett, Chief Engr.

Ore., The Dalles—Prelim. studies and estimates being made preliminary to bond election for earth dam and pipe line betw. Mill Creek and east fork of Hood River. Est. cost $300,000. Stevens & Koon, Spaulding Bldg., Portland, Cons. Engrs.

S. D., Rapid City—Plans being prepared by Cons. Engrs., Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., for water works impvts., $175,000. J. J. Hayes, City Council.

Wash., Bellingham—Election in December to vote on $1,000,000 bonds to change city's water supply from Lake Whatcom to Skookum Creek, 17 miles, from Lake Padden, the proposed reservoir.

Wash., Tacoma—City contemplates 75,000 h. p. development; reservoir to store 190,000 acre-ft. power plant, dam, transmission line, etc. Est. cost $7,768,000.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
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